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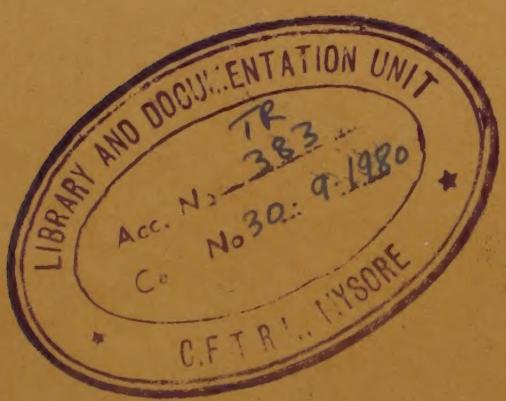
Tropical Products Institute

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The small-scale manufacture of carbonated beverages



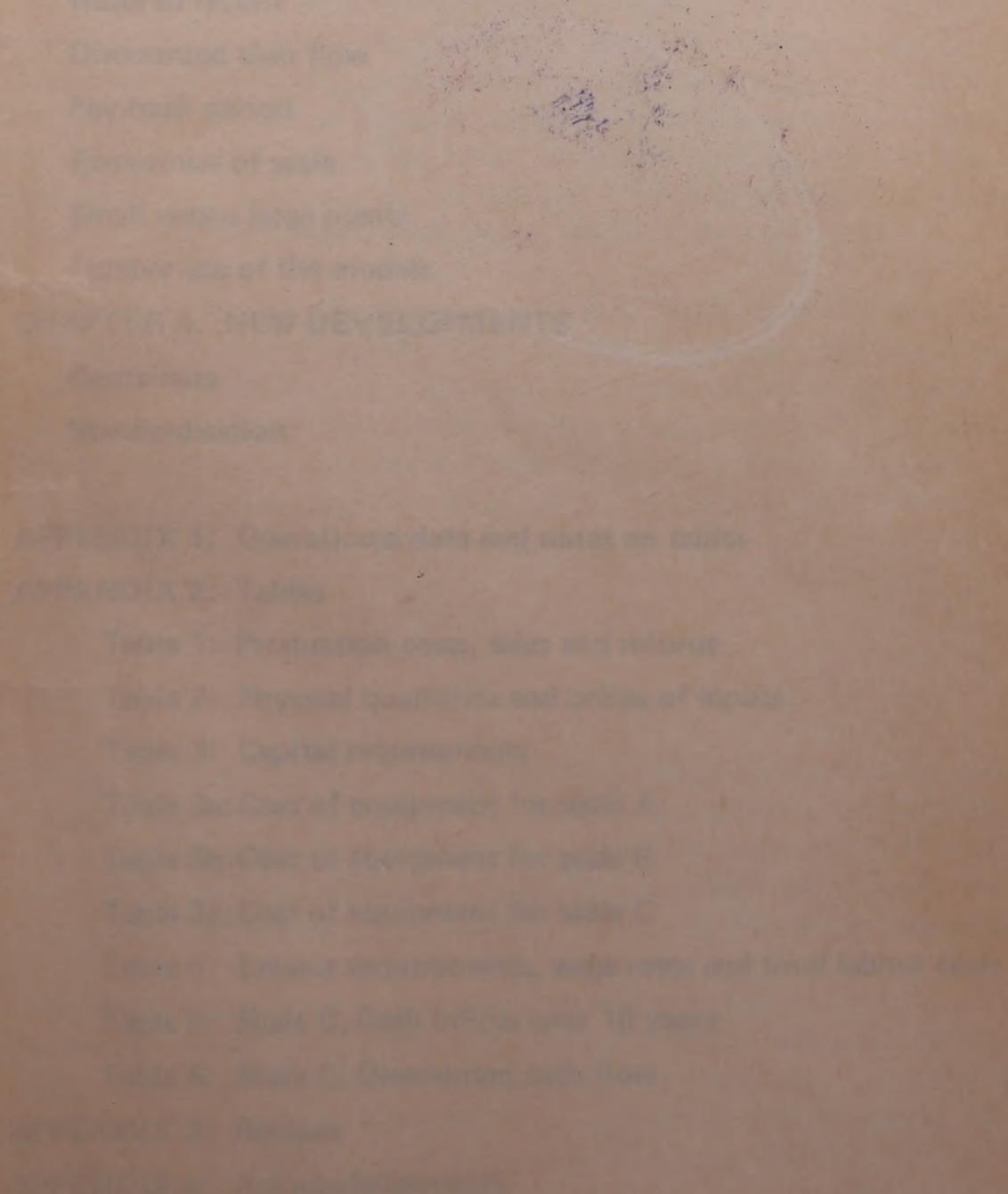
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MANUFACTURE



Tropical Products Institute

The small-scale manufacture of carbonated beverages

Jyoti Kamath



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Introduction

The purpose and scope of the report

This report is one of a series that has been initiated to help prospective investors in developing countries to assess the economic viability of various small scale industries. The manufacturing process is described, and cost models are worked out for different scales of output. Within the overall definition of small scale manufacture, the three scales A, B & C can be described as small, medium and large. These models are intended to be of very wide application to developing countries, so give a detailed breakdown of inputs in physical terms. However, in order to render them more comprehensive, money costs relating to conditions in Western Nigeria have been applied to the physical inputs to act as a concrete illustration. Users in other countries can then substitute their own actual local costs per physical unit to relate the general model to their particular cost conditions. The cost models also indicate the profits that the plants are expected to make, and the return on capital.

The present report deals only with the manufacture of carbonated beverages. Other soft drinks such as pure fruit juices, squashes made from fresh fruit and comminuted drinks are outside its scope. Among the carbonated beverages the manufacture of an orange flavoured drink has been taken as a representative case; and the costing is, therefore, done for this example only. However, with the application of the appropriate recipes, given in Appendix 3, the costs for other drinks can be worked out as well.

Method

The operational data for the three scales of output were collected from various firms engaged in the manufacture of carbonated beverages and complementary goods in the United Kingdom and in Nigeria. The detailed estimates of capital costs were supplied by one of the British manufacturers of machinery for the industry. Some additional information was obtained from Nigeria House and from published sources.

The cost information was then arranged and analysed by conventional accounting methods, deriving gross profit, net profit and return on capital. These calculations are set down in Tables 1 – 4, Appendix 2, and the details of the derivation of the figures are explained in Appendix 1. The data for scale C were further arranged in the form of cash inflows and outflows for ten years, the expected life of the plant. Following current fiscal practise in Nigeria, tax was then calculated at 40 per cent of gross profit, and deducted from the same, after providing for the initial and annual allowances. The plants are not allowed any other exemption from tax as the industry in Nigeria does not enjoy the status of pioneer industry. The internal rate of

return was then worked out on the basis of the after-tax inflow, that is, the rate of discount was found which made the discounted outflows approximately equal to the discounted inflows. Details of this calculation can be found in Tables 5 and 6 of Appendix 2.

Outline of the manufacturing process

The process of bottling carbonated beverages normally involves the use of purchased fruit emulsions or concentrates. It is possible, of course, to begin the process with the production of these flavourings from fresh fruit. However, it is found that large economies of scale are present in the production of these concentrates and emulsions, and in practise nearly all firms engaged in the manufacture of carbonated beverages buy ready-made emulsions. This procedure has the additional advantage of increasing product diversity since no economies of scale are lost through changing flavours, whereas the production of emulsions from fresh fruit is likely to involve the loss of such economies.

First, the dirty bottles are collected on one side and are thoroughly cleaned in the washing machine with a caustic detergent. A common type of machine consists of a moving chain which carries the bottles over and under sprays of detergent and hot clean water. Since the bottles are washed with caustic concentrates, it is important that the solution contains the correct concentration of caustic soda, and that the bottles are completely free from alkali after the wash. The clean sterile bottles then come out on a conveyor to be filled.

The syrup is meanwhile being prepared in tanks placed on an elevated surface. Normally three tanks are used to make the syrup. The sugar, weighed according to the recipe, is dissolved in water in one tank, and the orange emulsion, citric acid and benzoic acid are mixed in the correct proportions in a second tank. The third tank is used to mix the contents of the other two tanks. To a large extent the syrup determines the taste of the final product and it is essential, therefore, that the syrup is made of the right ingredients in the right proportion, is properly mixed and has the correct preservative content. It is necessary to ensure that the water used in making the drink, is pure, clear and treated, and that pure high grade refined white sugar is used which does not affect the taste, clarity or colour of the drink.

The ready syrup now flows through the tubes to the syruper, which puts a fixed quantity of syrup, normally 15 per cent of the bottle capacity, into the bottles. The bottles containing the syrup then arrive at the filler which tops them up with carbonated water. This comes from the carbonating machine which combines the water and carbon dioxide. Most carbonated beverages contain between 3½ and 4 volumes of carbon dioxide which imparts the characteristic taste to the drink. As soon as the bottles are filled with the carbonated water they are sealed with a crowner. Delay in sealing the bottles lets air in, drops the volume of carbonation and leaves the drink with a flat and insipid taste. Once the crowns are on the bottles they are conveyed to the mixer, a machine which turns and shakes the bottles in order that the syrup is properly mixed with the carbonated water.

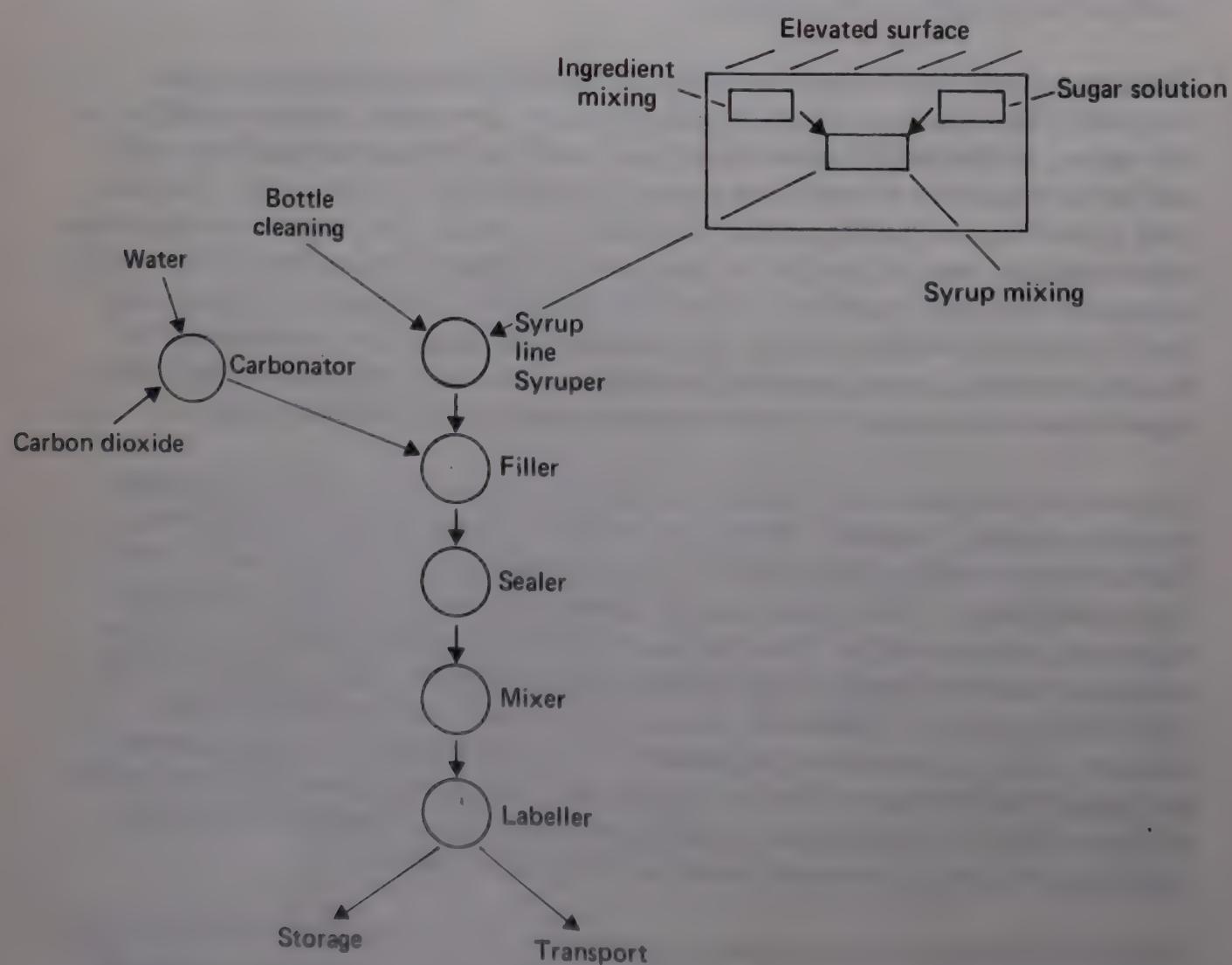
The filled bottles can now be labelled. At Scale A this can be done by hand, but is mechanised in the more advanced methods of production. Labels are of two types, those which are burned permanently on the bottles, and those which are stuck on.

The bottles are then packed in cartons by hand, and either stored for a few days or marketed straight away.

Quality control forms an essential part of carbonated drink production. In the simple process of Scale A, the quality of the product is checked only at the end of the process, whereas in the more sophisticated processes quality is checked at every stage. The most important points to be checked are; the cleanliness of the bottles, the nature of the water for syruping; the proportion of ingredients; the gas content of the carbonated water and finally the 'brix' or sugar content of the finished drink. This latter is most important since a small variation in sugar content can completely change the product.

Since this is a food industry, cleaning is essential and in this case the whole factory, including the syrup tanks, must be properly cleaned every day to ensure a high standard of hygiene. This cleaning must involve more than just the removal of visible dirt, it must also ensure the removal of invisible contaminants such as bacteria or yeasts which can easily develop on the surface of the machines. The plant and equipment is, therefore, cleaned first with a suitable detergent, and then is sterilised by the application of an appropriate agent. Only after the daily clean can the manufacturing cycle be said to finish.

The production method described above is called the 'post-mix' method, that is the syrup and the carbonated water are separate until mixed in the bottles. There is another method, known as the 'pre-mix' method in which the syrup and carbonated water are mixed before they go into bottles. The advantages of the pre-mix system are that it results in quicker production, as the filling has to be done only once, and that the drink is more consistent and uniform. Against these advantages, the pre-mixed solution is more exposed to contamination as it goes through the pipe and cylinder of the carbonater where foreign elements may be present. The danger, of course, can be avoided with extra hygienic care.



FLOW SHEET: this shows the important parts of the process and does not represent the actual layout of a factory.

Summary of results

Rates of return

The smallest of our models, Scale A, describes the actual manufacture of about 500,000 bottles per year, at 245 (10 fl.oz) bottles per hour for one shift per day. On the total investment of £N 7,580 the firm makes an annual loss of about £N 400, i.e. 5 per cent. This rises to a loss of 7 per cent on fixed capital alone. It should be noted from Table 3.2 that labour accounts for a comparatively large proportion of total costs in the case of Scale A, so that in countries where the cost of labour is significantly lower, production at this scale may still be feasible. However, assuming all other costs to remain constant, the unskilled labour wage bill would have to fall by a quarter if the plant were to break even, and the unskilled wage rate would have to be as low as £N 36 per year to yield a 10 per cent rate of return.

Production at Scale B is about 1,000 (10 fl.oz) bottles per hour, or 2,000,000 per year. On the total capital invested of £N 23,170 the gross annual profit before tax is £N 13,760, which yields a return on capital before tax of 59 per cent.

The model indicates that plant at Scale C which produces about 5,000,000 (7 fl.oz) bottles per year, (2,500 per hour), can make very large profits. The cash flow shown in Table 5 suggests that a profit of £N 38,060 would be made in the first year of operation, and that this would increase to £N 52,700 by the tenth year. If 10 years' average annual profit is taken, along the lines of the calculations made for scales A and B, the return on capital before tax and after depreciation works out at over 100 per cent.

It should be noted that the high rates of return postulated for operations at scales B and C rest on certain assumptions about the market for carbonated beverages. It should be stressed that this is a critical factor, and that a full market study should precede any detailed feasibility study based on the figures given here.

Discounted cash flow

In many cases the calculation of returns by the conventional methods used above may be found to be misleading. Therefore, for scale C a model has also been constructed which illustrates the use of the technique of discounted cash flow. This technique is superior insofar as payments throughout the whole life of the project are taken into account, and given an appropriate weighting by the application of a discount rate, or reverse interest rate. The discount rate can be usefully applied in one of two ways. The first is to take a discount rate which represents an adequate rate of return on capital, to apply this to the difference between inflows and outflows over the life of the project, and thereby to arrive at the 'net present value', which if positive, will indicate that the scheme is viable. This type of application is most

useful where alternative schemes are to be compared. The second type of application and that used here, is the 'internal rate of return'. This involves the discovery of whatever rate of discount equalises net inflows and outflows over the period of the scheme. This is more useful where a project is standing on its own in a decision situation.

In the case illustrated in Tables 5 and 6, it turns out that the internal rate of return is 80 per cent, that is lower than the return measured by conventional means. Where such a large rate of return is anticipated the use of discounting techniques is less useful than in cases where the anticipated return is lower, where the more detailed investigation implied by discounting will lead to more positive criteria for decision.

Pay-back period

A third, and cruder method of assessing the viability of an investment is to find the length of time over which the profits from operations will accumulate to a sum which will equal the initial investment. The appropriate formula for this calculation is:

$$\text{Pay-back period} = \frac{\text{Capital cost}}{\text{Gross profit before depreciation} - \text{tax.}}$$

Since, under the assumptions used, the plant at scale A cannot break even, though the loss reduces over time, it is inappropriate to use this formula. The pay-back period for scale B has been calculated as 2.3 years and that for scale C as 1.7 years. These results are consistent with the opinion of one of the machinery manufacturers who told us that they often advance a three years' loan to a customer to buy their machinery, as they reckoned that capital in the industry should easily be recovered in three years.

Economies of scale

If we compare the cost of production at the three different levels of output it appears that economies of scale are obtained when operations expand from scale A to scale B. The unit cost of production in the case of scale A is 8.69 pence per bottle while for scale B it is 6.92 pence. A similar comparison cannot, however, be so easily drawn between scales B and C, as the bottles used are not the same size, due to difference in the design of the plant. In order to make the production cost comparable the unit cost of production has been worked out in terms of cost per gallon rather than in terms of cost per bottle. Ex-factory costs of production per gallon are compared in Table (i).

Table (i)		Unit costs
Scale		£ per gallon
A		0.58
B		0.46
C		0.47
C		0.45

(packed in 10 fl.oz. bottles)

The cost per gallon thus appears to be lowest in the case of scale B. Though production at scale C is 75 per cent higher, the cost per gallon of drink is higher. It can be argued, however, that this does not indicate the existence of diseconomies of scale. At scale C, since the drink is packed in smaller sized bottles, more bottles are needed, and as a result, more labels, more crowns and more cartons. Table (ii)

shows that comparing scale B with scale C the cost of supplies increases by 5.47 per cent of total ex-factory cost. If the same output were to be packed in 10 fl. oz. bottles, other costs remaining the same, the cost of supplies would represent only 36.76 per cent of the total ex-factory cost, and Table (i) shows the unit cost per gallon would be lower than that for scale B. So economies of scale are being sacrificed to accommodate a different product mix.

Table (ii) Percentage of ex-factory cost

	Scale A	Scale B	Scale C 7 Fl. oz.	Scale C 10 Fl. oz. bottles
Ingredients	14.02	19.81	18.15	21.35
Supplies	28.92	39.19	44.66	36.76
Labour	40.97	22.89	17.17	20.19
Power, Fuel, Water	0.55	1.72	1.89	2.23
Transport	2.53	2.82	4.54	5.33
Other	13.02	13.58	13.59	14.14

In spite of the higher cost of production, the return on capital is highest at scale C. This could be explained either by low capital costs or by high revenues and in this case it is high revenue. By using smaller bottles the manufacturer appears to enter a different market, where proportionately higher prices can normally be charged. The higher revenue per bottle thus more than offsets the extra costs involved in using the smaller bottles.

Small versus large plants

Some of the existing plants in the carbonated beverage industry manufacture 24,000 or 42,000 bottles per hour, that is at a rate of about eight or twelve times greater than the largest scale considered in this report. This poses the question whether small plants can survive under competitive conditions of this nature. Our results suggest that although economies of scale exist in the industry, so that bigger plants can make higher profits, smaller plants can make sufficient profits to exist comfortably. The co-existence of plants of different scales in the industry can be explained by the fact that they often serve different markets and operate at different technological levels. The decision whether to operate on small or large scale, therefore, depends on the resources available and on the size of the market aimed at. Thus although the recent trend has been towards comparatively large scale manufacture, the economic viability of relatively small-scale operation in suitable situations does not seem to be in danger, given appropriate market conditions.

It can be seen from Table (ii) that at scale A labour, and in the other three cases the cost of supplies constitutes the greatest single item. Unlike many other industries the cost of the raw material is comparatively low as water is the main ingredient by volume of carbonated drinks and the cost of ingredients might be even lower if they were not imported. It is also apparent from the Table that as scale increases so does the degree of mechanisation, e.g. the capital invested per head of the total work force is £N 505 at scale A, £N 965 at scale B and £N 1170 at scale C. In other words scale A is a very simple and labour absorbing plant, scale B is semi-automatic and scale C is completely automatic. This is also reflected in the increasing incidence of cost of power. The higher percentage costs of transport at scales B and C reflect differences in the marketing and distribution system of the product. At scale C, with over 5 million bottles to be marketed, it is

unlikely that a firm will be able to sell them all in a local market. In order to reach wider markets in other centres of population the transport cost will thus increase more than proportionately.

Further use of the models

It is useful to examine the effects on the cost models when some of the basic assumptions are changed, especially to see what sort of margins of safety they offer. It can be seen, for example, that if the price of beverages were 3s. per case lower for scales B and C, the plant would just break even, lower prices would lead to loss. Similarly if it is postulated that the plants are only able to operate at 50 per cent of their capacity, due to lack of markets for example, then a loss of over 7 per cent would be made at scale B, while scale C could only maintain a profit in the region of 10 per cent, since more or less the same costs would have to be spread over a lower output. Looked at another way, using the original assumptions, scale B would break even after a fall in sales of nearly 20 per cent, or after an increase in costs of up to 24 per cent. The margin of safety is even higher in the case of scale C. The plant at that scale could absorb without loss a fall in revenue of nearly 24 per cent, or an increase in the cost of production of up to 31 per cent. Scale A can be seen to make a loss under virtually any conceivable economic conditions. It is suggested that users of this report carry out similar exercises with the models on the basis of their own cost structure.

New developments

Containers

Although it has been assumed that the drink is packed in glass bottles, the use of tin and plastic containers is widespread in the soft drinks industry. Plastic containers are not as yet technically suitable for holding carbonated beverages, though development is proceeding on the production of a hybrid plastic-glass bottle, which is a glass bottle having a thin external coating of polyethylene which may be suitable. There has, however, been a trend towards packaging in tins. One fact that emerges strongly is that all existing containers have some advantages and disadvantages, no one type of container is overwhelmingly superior to all others. Glass bottles give a clear view of the contents, have a good re-closure value, are traditional and are very well accepted by the consumer. On the other hand, they are heavy, breakable and relatively difficult to handle. Plastic bottles are light, show the contents, have a luxury image in some cases, are easy to handle and are not prone to breakage. Moreover, at throughputs of over 5 million bottles per year it is thought to be economic for bottling factories to produce their own plastic bottles, thus avoiding the necessity to store bottles, and enabling a rapid response to changes in demand. However, they are likely to be more expensive and have a shorter shelf life. Cans are light, unbreakable, easy to handle and cheap in developed countries. They are unbeatable for speed of filling and closing, and can easily be opened with the new 'ring-pull' ends. However, they have the disadvantages of comparatively poor visual appeal, lack of flexibility in shape and difficulty of re-closure. Moreover the initial cost of a canning line is high and the cans themselves are expensive.

It is difficult to forecast the future of containers in general, though in developed countries, with the widespread existence of self-service supermarkets, a definite preference for one-trip containers has emerged. Increases in income reduce the incentive to collect the deposit on returnable bottles and manufacturers find it more profitable to produce non-returnables. The trend away from glass bottles has been reversed in the United Kingdom recently with the widespread introduction of disposable one-trip bottles, there have been a 300 per cent increase in less than three years. However, in developing countries where bottles are relatively more expensive it is probable that the introduction of one-trip bottles would add too much to the cost of production. In the long run, however, these trends are likely to be reflected in the developing countries, so that it is desirable to keep abreast of developments in packaging.

Standardisation

At present a wide range in packaging materials exists in the carbonated beverages industry, and within the range of glass bottles, for example, there are different

sizes, shapes and colours with various types of closure. This lack of standardisation tends to increase costs without improving the quality of the product in any way. Similarly there is a lack of standardisation of cartons, as far as materials, depth and divisions are concerned and lack of standardisation of pallets. Efforts should, therefore, be made to ensure that within a plant such standardisation is effected in order to reduce costs and as far as possible manufacturers should promote standardisation on an industry wide basis.

Appendix 1

OPERATIONAL DATA AND NOTES ON TABLES

Note should first be taken of certain fundamental assumptions made in constructing the cost models. These are as follows:-

1. The factory operates on one eight hour shift for 5½ days per week, 260 days per year. However, the models can be adapted to show the effects of working a greater number of shifts or days.
2. The operating efficiency is 70 per cent of the throughput specified by the machinery makers.
3. Bottles, sugar, citric acid, orange emulsion and sodium benzoate are imported. All other inputs are available locally.
4. Where prices have been converted into Nigerian currency from Sterling a factor of .857 has been used.
5. The prices quoted are those prevailing in early 1969.

Table 1

The figures given in Table 1 can be derived for the most part from information given in Tables 2 to 4 and from the recipe given in Appendix 3. However, the following items need further explanation:-

line 7 — Bottles: on the advice of firms in the carbonated beverages industry, the figures for the yearly quantity of bottles required allow for an average life of 10 trips per bottle, which takes into account 5 per cent breakage on the production side and 5 per cent loss after sale. The figure for yearly consumption is based on a purchase of 10 per cent of the annual throughput of bottles and the value of sales is adjusted for deposits of 6d recovered on the 5 per cent of 10 fl.oz. bottles lost, and 3d recovered on the 7 fl.oz. bottles lost.

line 8 — Cartons: Each carton contains 24 bottles. It is assumed that 50 per cent of cartons make a second trip, and 10 per cent make a third.

line 16 — Transport: The figures for transport costs are derived from the following table:-

Transport cost at different scales of output			£Nigerian 1969
	Scale A	Scale B	Scale C
Fuel	52	347	1,386
Insurance	100	250	500
Tax	30	80	160
Maintenance	30	100	200
Tyres	80	160	640
	<u>292</u>	<u>937</u>	<u>2,886</u>

The following assumptions have been made in constructing the table:

Scale A – The weight of a carton of full bottles is 26.5 lb, so the total weight to be transported per day is 2,173 lb, slightly less than a ton. Since, owing to poor road conditions, lorries in Nigeria are prohibited from carrying their maximum load, it has been assumed that a plant operating this scale would require a 1½ ton four-wheel diesel van. It has been assumed that this will travel 20 miles per day and use 1 gallon of fuel per 20 miles at 4/- per gallon.

Scale B – The total weight to be carried is approximately 4 tons per day and it is assumed that the firm buys two 3 ton lorries. Each lorry travels 50 miles per day at 15 miles per gallon.

Scale C – The weight of a full carton of 7 fl.oz. bottles is 20.25 lb, so the total weight to be transported per day is 7.6 tons. Since the beverage would have to be transported for longer distances in order to reach a market of the size postulated, it has been assumed that a firm of this size would need to buy at least four 3 ton lorries. Each of these lorries is assumed to travel 100 miles per day at 15 miles to the gallon. Tyres cost £40 each, for scale A & B it is assumed that a pair of new tyres per year will be bought and for scale C that a new set of tyres per year will be required.

line 17 – Rent: The difference in rents between the different scales is explained by the fact that while Scale A and B plants are assumed to be viable in small communities at scale C the plant will need to be established in an urban area of some size where rents can be expected to be high.

Table 2

The following points should be noted:

1. line 7 – Bottles and line 8 – Cartons. The figures given in the 'per shift' columns refer to the average number of new bottles and cartons per shift and not to the total number of bottles required. The total requirements can be calculated by multiplying the number of bottles by 10 and for cartons by dividing the total number of bottles by 24.
2. column 0: The figures in this column are derived from the recipe in Appendix 3.

3. The figures for quantity per shift have been rounded in many instances but the annual quantities have been calculated from the unrounded figures, which will account for any discrepancies that may have arisen.

Table 3

1. The figures in this table have been rounded to the nearest £10.¹ Totals have been calculated from the unrounded data, so may not agree with the rounded entries.
2. Building: Scale A — 900 sq. ft. at £2.5 per sq. ft.
Scale B — 1,400 sq. ft. at £3 per sq. ft.
Scale C — 1,700 sq. ft. at £3 per sq. ft.

Tables 3 a, b, c.

1. Insurance and freight is calculated at 6 per cent of f.o.b. price.
2. Duty is added at 5 per cent of c.i.f. price.
3. Valuation certificates cost £10 per item.

Table 5

Though no precise marketing study estimating future prices is available the following assumptions have been made:-

1. Owing to the present inflationary trends in western countries, it is assumed that all imported items will increase in price by 5 per cent per year, i.e. lines 1 — 4 and 7.
2. The Gross Domestic Product of Nigeria increased at an average rate of 6 per cent per year over the period 1958—9 to 1966—7 and it is postulated that this rate of growth will continue. An increase of 3.5 per cent per year in the wage rate seems consistent with this rate of growth, since wage rates often lag in developing countries. This applies to lines 11, 12 and 27.
3. On this basis it seems reasonable to assume that prices will increase by 3 per cent per year and this rate has been taken for lines 5, 6, 8, 9, 10, 16, 20, 21 and 29.
4. All other costs are assumed to be fixed or inflexible. Excise duty which is already high is not expected to increase.

Table 6

Column b: It is assumed that lorries are replaced every three years and that they increase in price by 3 per cent per year. The figure for year 11 represents the scrap value of the plant (5 per cent of initial cost plus installation) plus the residual value of the building (10 per cent of initial value), plus imputed value of lorries (33.3 per cent) of year 9.

Column c: Since the cost of inputs is increasing annually, see table 5, working capital requirements will increase annually. It is assumed that the working capital is recovered at the end of the investment.

Column d: From Table 5, line 30.

Column e: 40 per cent of column d with a lag of one year. It is assumed that tax on profits in year n is paid in year n+1.

Column f: Nigerian company tax law makes the following allowances to be set against the tax: An initial allowance of 10 per cent of the value of buildings and 15 per cent of plant and installation cost together with an annual allowance of 5 per cent on buildings and 10 per cent on plant and installation. The figures in column f are, therefore, 40 per cent of the value of these allowances.

Column g: Column b plus column c.

Column h: Column d plus column f minus column e.

Column i: The rate of discount is that which most nearly makes the sum of column j minus the sum of column k = 0.

Column j: Column g multiplied by column i.

Column k: Column h multiplied by column i.

Appendix 2

TABLES

Table 1 : Production costs, sales and returns

1969 Nigerian £

		Scale A	Scale B	Scale C	Explanation and Sources
	a	b	c	d	e
Ingredients					
1	Sugar	1,031	4,242	7,424	Table 2
2	Citric acid	93	382	668	"
3	Orange emulsion	243	999	1,747	"
4	Sodium benzoate	4	16	29	"
5	Carbon dioxide	213	875	1,531	"
6	Washing detergent	36	72	150	"
		1,620	6,586	11,549	
Supplies					
7	Bottles.....	919	3,783	7,250	Table 2 and Appendix 1
8	Cartons.....	1,510	6,006	13,081	"
9	Closures.....	488	2,009	5,023	Table 2
10	Labels.....	425	1,223	3,058	"
		3,342	13,021	28,412	
Labour					
11	Unskilled workers	1,560	2,310	3,420	Table 4
12	Staff	3,175	5,300	7,500	"
		4,735	7,610	10,920	
Power, Fuel & Water					
13	Electricity	18	273	609	Table 2
14	Oil.....	—	197	415	"
15	Water	45	102	180	"
		63	572	1,204	
Other costs					
16	Transport	292	937	2,886	Appendix 1
17	Rent on land	4	6	100	"
18	Insurance (a) building	6	10	13	0.25 per cent of value of buildings (line 3, Table 3)
	(b) plant	6	33	65	0.45 per cent of value of plant (line 1, Table 3)
	(c) stock.....	6	25	50	0.75 per cent of value of stock (2 months ingredients and supplies)
19	Repairs and maintenance	177	572	977	5 per cent buildings and equipment (line 1 plus line 3, Table 3)
20	Miscellaneous.....	100	200	500	Estimates
21	Quality control.....	—	200	300	"
22	Unforeseen.....	1,035	2,977	5,698	10 per cent of the total lines 1 – 21
23	Interest on working capital	171	491	940	9 per cent of working capital, (line 6, Table 3)
24	Total ex-factory costs.....	11,557	33,240	63,614	Total lines 1 – 23
25	Depreciation: (a) plant.....	130	726	1,446	10 per cent of plant (line 1, Table 3)
	(b) building.....	112	210	255	5 per cent of buildings (line 3, Table 3)
	(c) lorries.....	500	1,333	2,667	33.1/3 per cent of lorries (line 4, Table 3)
26	Cost of advertisement.....	902	3,713	7,098	5 per cent of sales (line 30)
27	Excise duty.....	4,247	17,472	26,390	
28	Salesman.....	1,000	3,800	6,800	48d per carton Scale A & B, 29d per carton Scale C. See Table 4
29	Total cost of sales.....	18,448	60,494	108,270	Sum of lines 24 to 28
30	Sales.....	18,048	74,256	141,960	204d per carton of 10 fl. oz. bottles, 156d per carton of 7 fl. oz. bottles
31	Gross profit before tax.....	—400	13,762	33,690	Line 30 less line 29
32	Return on capital before tax (per cent)	—5%	59%	80%	Line 31 as percentage of line 7, Table 3

Footnote:

_____ subtotal

Table 2 : Physical quantities and prices of inputs

Inputs	Unit	Scale A.				Scale B				Scale C			
		Quantity per shift	Quantity per year	fob price pence (sterling)	Delivered price Nigeria pence	Quantity per shift	Quantity per year	fob price pence (sterling)	Delivered price Nigeria pence	Quantity per shift	Quantity per year	fob price pence (sterling)	Delivered price Nigeria pence
1	lb	128.6	33,442	NA	7.4	529.2	137,592	NA	7.4	926	240,786	NA	7.4
2	lb	2.3	597	25.18	37.3	9.5	2,457	25.18	37.3	4,300	25.18	37.3	1.05 lb
3	lb	1.2	299	102	195	4.7	1,229	102	195	2,150	102	195	0.3 oz
4	lb	0.11	28	25.18	32.8	0.45	117	25.18	32.8	211	25.18	32.8	0.15 oz
5	lb	11.4	2,968	7.5	17.2	47	12,211	7.5	17.2	21,369	7.5	17.2	0.014(25) oz
6	gal	—	120	NA	72	—	240	NA	72	—	500	NA	72
7	Bottles	no	196	50,960	—	4.63	806	209,664	—	4.63	2,016	524,160	3.5
8	Cartons	no	51	13,272	NA	27.3	210	54,600	NA	26.4	525	136,500	23.0
9	Closures	no	1,960	509,600	NA	0.23	8,064	2,096,640	NA	0.23	20,160	5,241,600	0.23
10	Labels	no	1,960	509,600	NA	0.20	8,064	2,096,640	NA	0.14	20,160	5,241,600	0.14
11	Electricity:												
	(a) Demand charge	kVA	0.4	0.4	NA	360/month	5.7	5.7	NA	360/month	13.2	NA	330/month
	(b) Running charge	kWh	3.4	884	NA	3	52.4	13,614	NA	3	120.4	31,294	3
12	Oil	gal	—	—	—	—	5.04	1,310	NA	36	10.64	2,766	36
13	Water total:	000gal	0.7	181	NA	60	1.6	408	NA	60	2.8	719	60
	(a) for syrup	gal	10	2,564	—	—	41	10,549	—	71	18,460	148.88 fl oz	148.88 fl oz
	(b) for carbonation	gal	104	27,073	—	—	428	111,384	—	750	194,922	12.88 fl oz	12.88 fl oz
	(c) for washing machine	gal	572	148,720	—	—	1,080	280,800	—	1,920	499,200	136 fl oz	136 fl oz
	(d) for cleaning	gal	10	2,600	—	—	20	5,200	—	25	6,500	—	—

Sources:

See Chapter 1 'Method' and Appendix 1.

Table 3 : Capital requirements

Nigerian £ 1969

	Scale A	Scale B	Scale C	Explanation
	a	b	c	d
1. Equipment.....	1,300	7,260	14,460	See Tables 3a, b, c
2. Installation.....	110	640	1,290	10 per cent of fob price of equipment
3. Building.....	2,250	4,200	5,100	See Appendix 1
4. Lorry.....	1,500	4,000	8,000	"
5. Unforeseen.....	520	1,610	2,880	10 per cent of sum of lines 1 - 4
6. Working capital.....	1,900	5,460	10,450	2 months running costs (Table 1 lines 1 - 22)
7. Total fixed investment	7,580	23,170	42,180	

Source:

Machinery makers

Footnote:

Figures in this table have been rounded to the nearest £10

Table 3a : Cost of equipment for scale A

	List of equipment	Maximum throughput per hour	h.p. per unit	fob price (£ sterling) 1969	fob (Nigerian £) 1969
	a	b	c	d	e
1	'Meadow' batch type bottle washing machine.....	192 bottles	—	250	214
2	Stainless steel mixing pan.....	30 gal	—	NA	50
3	Stainless steel storage pan.....	30 gal	—	NA	50
4	Stainless steel agitating pan.....	30 gal	—	NA	50
5	'Delhi' carbonator, filler and crowner.....	350 bottles	0.5	850	729
6	Set of spares for 'Delhi'.....	—	—	40	34
7	Quality control apparatus.....	—	—	25	21
8	Total.....		0.5		1,148
9	Insurance and freight.....				69
10	Total price cif.....				1,217
11	Duty.....				61
12	Valuation certificates.....				20
13	Total outlay.....				1,298

Source:

Machinery makers

Table 3b : Cost of equipment for scale B

List of equipment	Maximum Capacity	hp per unit	fob price	fob price
			(£ sterling)	(Nigerian £)
a	b	c	d	e
1 "Apex" washing machine L-3/120.....	1,440 bottles	3	1,255	1,076
2 One set of spare parts for machine L-3/120.....			95	81
3 "Bratby" No 3 "Disc" water filter.....	660 gal	½	201	172
4 One set of recommended spares.....			41	35
5 50 gallon "Bratby" mixer, filter.....	100 gal	½ + ½	422	362
6 One set of spare parts.....			46	39
7 "Bratby" 50 gallon syrup storage tank.....	50 gal		114	98
8 "Bratby" 50 gallon agitating tank.....	50 gal	2/3	227	195
9 Oil fired re-circulating boiler.....	126,000 B.Th.U	½	450	386
10 "Speedwell" syruper, filler, crowner.....	1,440 bottles	1	1,695	1,453
11 One set of spare parts for "Speedwell".....			129	111
12 HSX conveyor.....			608	521
13 "Rapid X" automatic carbonator.....	180 gal	¾	1,061	909
14 One set of spare parts for carbonator.....			33	28
15 "Thermal" gas tube stand.....			101	87
16 Junior labelling machine	2,640 bottles	¾	665	570
17 Simple quality control apparatus.....			350	300
18 Total.....		7.667	7,493	6,422
19 Insurance and freight.....			450	386
20 Total price cif.....			7,943	6,807
21 Duty.....			397	340
22 Valuation certificates.....			128	110
23 Total outlay.....			8,468	7,257

Source:

Machinery makers

Table 3c : Cost of equipment for scale C

List of equipment	Maximum Capacity	hp per unit	fob price	fob price
			(£ sterling)	(Nigerian £)
a	b	c	d	e
1 "Autospeed 16" syruper-filler-crowner.....	3,600 bottles	2	4,216	3,613
2 One set of spare parts.....			303	260
3 "Centaur" soaker-hydro bottle washing machine	300 doz bottles	4	3,950	3,385
4 One set of spare parts.....			150	129
5 "Rapid X" automatic carbonator.....	180 gal	¾	1,061	909
6 One set of recommended spare parts.....			33	28
7 10 ft inter-connecting piping between "Autospeed" and "Rapid X" carbonator.....			18	15
8 Additional bottle conveyor inclusive of accumulating table and sighting box.....			325	279
9 4 Tube "Thermal" gas tube stand with TRV reducer gas manifold warning device to work in conjunction with carbonator.....				
10 "Bratby" No 3 "Disc" water filter.....	660 gal	½	101	87
11 One set of spare parts.....			201	172
12 "Bratby" 100 gallon capacity syrup mixer filter.....	100 gal	1	41	36
13 One set of spare parts.....			642	550
14 "Bratby" 100 gallon capacity agitating tank.....	100 gal	1	49	42
15 "Bratby" 100 gallon capacity syrup storage tank.....	100 gal	1	305	261
16 "Patonic" 250 oil fired boiler.....			208	178
17 One set of spare parts.....		1/6 + 1/4	800	686
18 "Bratby" water cooling plant size "X1".....			87	75
19 Spare parts.....		7½	1,579	1,353
20 Syrup cooler.....	60 gal	½	76	65
21 Spares.....			375	321
22 Quality control equipment.....			14	12
			500	428
23 Total.....		18hp	15,034	12,884
24 Insurance and freight.....			902	773
25 Total price cif.....			15,936	13,657
26 Duty.....			797	683
27 Valuation certificates.....			140	120
28 Total outlay.....			16,873	14,460

Table 4 : Labour requirements, wage rates, and total labour costs

	Labour requirements			Wage rate or salary per head per annum 1969 Nigerian £			Total cost per year 1969 Nigerian £		
	Scale A	Scale B	Scale C	Scale A			Scale B		
				•	•	•	•	•	•
a Direct Labour									
1 Collection of bottles.....	1	2	2	150	150	150	150	300	300
2 Washing machine.....	1	1	1	150	150	150	150	150	150
3 Carry to the filler or conveyor.....	1	—	—	150	—	—	150	—	—
4 Syrup mixing tanks.....	—	1	1	—	150	150	150	150	150
5 Syuper, filler, crowner.....	2	2	2	150	150	150	150	300	300
6 Carbonator.....	1	1	1	150	150	150	150	150	150
7 Carry to labelling machine or accumulating table.....	—	—	—	150	—	—	150	—	—
8 Label and crates.....	1	1	2	150	150	150	150	150	300
9 Handling and loading.....	1	1	2	150	150	150	150	150	300
10 Truck driver.....	1	2	4	160	175	175	160	350	700
11 Helper to truck driver.....	—	2	4	—	160	160	—	320	640
12 Cleaner (½ time).....	1	2	4	50	70	70	50	140	280
Sub total.....	11	16	24	—	—	—	1,560	2,310	3,420
Staff									
13 Manager.....	1	1	1	1,800	2,000	2,500	1,800	2,000	2,500
14 Maintenance engineer.....	1	1	1	1,200	1,500	1,800	1,200	1,500	1,800
15 Analyst.....	—	1	1	—	1,000	1,200	—	1,000	1,200
16 Foreman.....	—	1	2	—	600	800	—	600	1,600
17 Clerk and/or secretary.....	1	1	2	175	200	200	175	200	400
Sub total.....	3	5	7	—	—	—	3,175	5,300	7,500
18 Total labour cost.....	18	—	—	—	—	—	4,735	7,610	10,920
Sales Staff									
19 Salesmen.....	1	2	4	1,000	1,000	1,200	1,000	2,000	4,800
20 Sales Manager.....	—	1	1	—	1,800	2,000	—	1,800	2,000

Footnote:

sub total

Source:

Chapter 1

Table 5 : Scale C, Cash inflow over 10 years

Year	1	2	3	4	5	6	7	8	9	10
1	Sugar.....	7,424	7,795	8,185	8,594	9,024	9,475	9,949	10,446	11,517
2	Citric acid.....	668	701	736	773	812	853	895	940	1,036
3	Orange emulsion.....	1,747	1,834	1,926	2,022	2,123	2,230	2,341	2,458	2,710
4	Sodium benzoate.....	29	30	32	34	35	37	39	41	45
5	Carbon dioxide.....	1,531	1,577	1,624	1,673	1,723	1,775	1,828	1,883	1,998
6	Detergent.....	150	155	159	164	169	174	179	184	196
7	Bottles.....	7,250	7,613	7,993	8,393	8,812	9,253	9,716	10,201	11,247
8	Cartons.....	13,081	13,473	13,878	14,294	14,723	15,164	15,619	16,088	17,068
9	Closures.....	5,023	5,174	5,329	5,489	5,653	5,823	5,998	6,178	6,363
10	Labels.....	3,058	3,150	3,244	3,342	3,442	3,545	3,651	3,761	3,874
11	Workers.....	3,420	3,540	3,664	3,792	3,925	4,062	4,204	4,351	4,503
12	Staff.....	7,500	7,763	8,034	8,315	8,606	8,908	9,219	9,542	10,222
13	Electricity.....	609	609	609	609	609	609	609	609	609
14	Oil.....	415	415	415	415	415	415	415	415	415
15	Water.....	180	180	180	180	180	180	180	180	180
16	Transport.....	2,886	2,973	3,062	3,154	3,248	3,346	3,446	3,549	3,766
17	Rent on land.....	100	100	100	100	100	100	100	100	100
18	Insurance									
	(a) building.....	13	13	13	13	13	13	13	13	13
	(b) plant.....	65	65	65	65	65	65	65	65	65
	(c) stock.....	50	52	54	56	58	60	63	65	68
19	Repairs & maintenance.....	977	977	977	977	977	977	977	977	977
20	Miscellaneous.....	500	515	530	546	563	580	597	615	633
21	Quality control.....	300	309	318	328	338	348	358	369	380
22	Unforeseen.....	5,698	5,901	6,113	6,333	6,561	6,799	7,046	7,303	7,570
23	Interest on working capital..	940	974	1,009	1,045	1,083	1,122	1,163	1,205	1,249
24	Total ex-factory costs.....	63,614	65,888	68,249	70,706	73,257	75,913	78,670	81,538	84,522
25	Cost of advertisement.....	7,098	7,311	7,530	7,756	7,989	8,229	8,475	8,730	8,992
26	Excise duty.....	26,390	26,390	26,390	26,390	26,390	26,390	26,390	26,390	26,390
27	Salesmen.....	6,800	7,038	7,284	7,539	7,803	8,076	8,359	8,651	8,954
28	Total cost of sales.....	103,902	106,627	109,453	112,391	115,439	118,608	121,894	125,309	128,858
29	Sales.....	141,960	146,219	150,605	155,124	159,777	164,571	169,508	174,593	179,831
30	Gross profit before tax.....	38,058	39,592	41,152	42,733	44,338	45,963	47,614	49,284	50,973

Source:

Table 1. Appendix 1

Footnote:

subtotal

Table 6 : Scale C, Discounted cash flow

Year	Fixed capital	Working capital	Gross profit	Tax	Allowances	Net Outflow b + c	Net inflow d + f - e	80 per cent discount factor	Discounted outflow	Discounted inflow
0	.	31,733	10,446	38,058	10,446	31,733	31,733	1	31,733	31,733
1	8,742	373	39,592	15,223	1881	373	38,058	0.556	5,808	21,160
2		388	41,152	15,837	732	9,130	26,250	0.309	115	8,111
3		403	42,733	16,461	732	403	26,047	0.171	1,561	4,454
4		419	44,338	17,093	732	419	27,004	0.095	38	2,565
5		436	45,963	17,735	732	9,988	27,977	0.053	22	1,483
6		453	47,614	18,385	732	453	28,960	0.029	290	840
7		471	49,284	19,046	732	471	29,961	0.016	7	479
8		490	50,973	19,714	732	10,928	30,970	0.009	4	279
9	10,438	509	52,682	20,389	732	509	31,991	0.005	55	160
10				21,073	732	-19,164	33,025	0.003	2	99
11	- 4,776		- 14,388			- 20,341	0.002	- 38	- 41	
									Total	39,597
										39,589

Sources:

Tables 1 to 5 and Appendix 1

Footnote:

remainder 8, therefore internal rate of return is close to 80 per cent.

Appendix 3

RECIPES

The recipes for making various carbonated drinks are given below:-

Orange Squash

Sugar	7 lb.
Citric Acid	2 ozs.
Orange Emulsion	1 fl. oz.
Anteferment Liquid Preservative	$\frac{1}{2}$ fl. oz.
(16% solution of Benzoic Acid)	
Water to make one gallon	

Lemon Drink

Sugar	7 lb.
Citric Acid	2 $\frac{1}{2}$ ozs.
Essence	1 fl. oz.
AL Preservative	$\frac{1}{2}$ fl. oz.
(16% solution of Benzoic Acid)	
Water to make one gallon	

Kola

Sugar	7 lb.
Concentrate	10 fl. ozs.
Anteferment Liquid preservative	$\frac{1}{2}$ fl. oz.
(16% solution of Benzoic Acid)	
Water to make one gallon	

Soda

Sugar	7 lb.
Citric Acid	$\frac{1}{4}$ oz.
Essence	$\frac{1}{2}$ fl. oz.
Heading liquid	$\frac{1}{2}$ fl. oz.
AL Preservative	$\frac{1}{2}$ fl. oz.
(16% solution of Benzoic Acid)	
Water to make one gallon	

Ginger Ale

Sugar	6 lb.
Citric Acid	2 ozs.
Essence	1 $\frac{1}{2}$ fl. oz.
Colour Liquid Ginger Ale	$\frac{1}{2}$ fl. oz.
AL Preservative	$\frac{1}{2}$ fl. oz.
(16% solution of Benzoic Acid)	
Water to make one gallon	

Each of these recipes produce one gallon of bottling syrup which should be used at the rate of 1½ fl. ozs. per 10 oz. bottle and filled up with carbonated water in the usual way.

Prices of Essences and Concentrates

In £ Sterling, 1970

Flavour	CIF Price excluding duty shilling	Duty (107½ per cent) shilling	CIF Price including duty shilling
Orange	9/2 per lb	9.855	19.021 per lb
Lemon	12/8 per lb	13.617	26.284 per lb
Cream Soda	10/8 per lb	11.467	22.134 per lb
Tonic Water	28/8 per lb	30.817	59.484 per lb
Ginger Ale	11/8 per lb	15.542	24.209 per lb
Kola	50/10 per gall.	54.645	105.478 per gall.

Appendix 4

ACKNOWLEDGEMENTS

Besides colleagues at the Tropical Products Institute, many individuals and organisations were asked to supply the information or advice on which this report is based and the help of all is gratefully acknowledged. There follows a list of firms and other outside organisations which gave information actually used in the report. (However, none of the models represents the entire practice of any particular firm).

A full list of suppliers of machinery, equipment and other requirements of the soft drinks industry is published monthly in the **Soft Drinks Trade Journal**, The Gate House, 2 Holly Road, Twickenham, Middlesex, England.

1. Barnett, Foster & Bratby (Export) Ltd.,
Gorton Lane,
MANCHESTER 18, England.
2. The United Africa Company Ltd.,
PO Box 1 United Africa House,
Blackfriars Road,
LONDON SE1, England.
3. Nigeria High Commission,
9 Northumberland Avenue,
LONDON WC2, England.
4. Barnett & Foster Ltd.,
Denington Estate,
Wellingborough,
NORTHANTS, England.
5. Bordpak Ltd.,
7 Dockyard Road,
PO Box 369, Apapa,
NIGERIA.
6. Schweppes (Overseas) Ltd.,
Schweppes House,
Connaught Place,
LONDON W2, England.

7. The Distillers Company (Carbon Dioxide) Ltd.,

Cedar House,
39 London Road,
Reigate,
SURREY, England.

8. Bush Boake Allen Ltd.,

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LONDON E8, England.

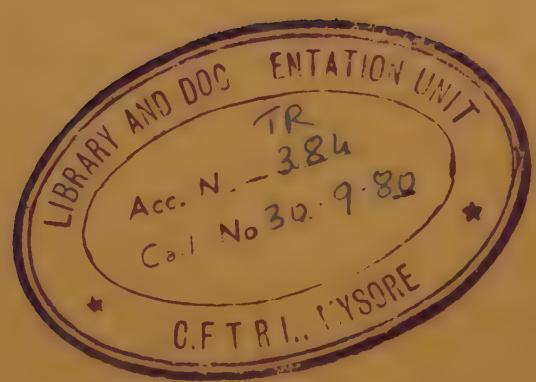
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The processing of macadamia nuts





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July 1971

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Foreign and Commonwealth Office (Overseas Development Administration)

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The processing of macadamia nuts

INTRODUCTION

The *Macadamia*, a member of the Proteaceae family, is a sub-tropical evergreen tree which produces edible nuts renowned for their quality. The nuts are claimed to be superior in flavour and texture to any other confectionery nut, and are probably the most highly priced processed nut available in the world.

Macadamia nuts are retailed almost entirely in processed form, as roasted and salted kernels. They are not easily processed, the shells being very difficult to crack, while the delicate flavour of the kernel is easily lost unless the nuts are handled with care from the time of harvesting until the final vacuum packaging of the product. Because of the problems associated with decortication, the demand for nuts in shell is small.

Production

Commercial production of macadamia nuts has become firmly established in the Hawaiian Islands and has expanded considerably during the last decade. However, although classed as a luxury commodity, production still falls far short of the market demand. Production in its native Australia has also expanded in recent years but remains only a fraction of the Hawaiian output. Successful attempts have been made to develop the crop in several tropical and subtropical areas including California and Florida, USA, Central and South America and East and Southern Africa. Because of this wide adaptability, the macadamia may well become of economic importance in various tropical as well as sub-tropical countries as a new export crop in the programme of crop diversification.

Species Suitable for Processing

Considerable confusion exists in the literature on the nomenclature of *Macadamia* spp. Ten different species are currently recognised, six native to Australia, three native to New Caledonia and one native to Celebes. However, only two, *Macadamia tetraphylla* and *Macadamia integrifolia*, are grown commercially, the remainder producing small nuts containing bitter cyanogenetic kernels which render them unpalatable and quite unsuitable for edible purposes. The Hawaiian Industry is based almost exclusively on *M. integrifolia*, varieties of which have, under their experience, proved best both as an orchard tree and as a processed nut.

When grown under favourable conditions, trees of the two commercial species may obtain a height of 60 feet or more, and a spread of 40 feet. The nuts are borne profusely, in long grape-like open clusters, each nut being enclosed in a fleshy green husk.

M. integrifolia, commonly referred to as the 'smooth-shell' species, often flowers while fruiting and hence produces nuts over a long period. The kernel is white,

fairly uniform in quality, and shrinks only slightly after harvesting. *M. tetraphylla*, the "rough-shell" species, on the other hand, produces one main crop over a short period. The kernel has a greyish colour and is more variable in quality than the *integifolia* species. The kernels tend also to shrink more after harvesting.

Varieties

Three varieties of *M. integrifolia*, Kakea, Ikaika and Keauhou, have been planted extensively in the Hawaiian Islands. All three varieties give satisfactory production under a variety of favourable conditions. Yields from mature grafted trees can be as high as 200 lb per annum after 16 years, and may be expected to reach 300 lb per tree in double that time.

A new variety Keau has more recently been recommended for commercial planting in Hawaii. This variety is said to be highly resistant to wind, with an overall yield 5 – 10 per cent greater than previous varieties, the entire crop of nuts maturing and dropping before the end of November.

In Australia, most of the present crop is based on *M. tetraphylla* trees, although orchards of grafted *integifolia* varieties should soon be bearing.

Nut Quality

A number of factors need to be taken into account when assessing nut quality.

- (i) Size and shape of nut: Nuts should be spherical or nearly so, otherwise problems in grading prior to cracking occur.
- (ii) Shell thickness and kernel percentage: Nuts with a medium or thick shell are brittle and crack more readily using a compression type of decorticating machine. Thin shelled nuts on the other hand are less brittle, often resulting in kernels breaking during decortication. Nuts with very thin shells at the apical end are readily attacked by ants and also frequently germinate while still on the tree. The dehydrated kernel should be 33 per cent or more of the total weight of the nut.
- (iii) Size and shape of kernel: Kernel size and weight are highly correlated and weight is usually the criterion used. Kernel weight should be more than 2.0g to avoid excessive labour costs in sorting and grading. On the other hand, kernels over 3.0g in weight cause problems of heat penetration during cooking, and are too large for attractive presentation.
- (iv) Colour: Raw kernels should be white or light cream in colour, with little or no discolouration at the apical end. Roasted kernels should be a uniform golden brown colour.
- (v) Palatability: First grade kernels should have an oil content of 72 per cent or more, while second grade kernels an oil content of not less than 67 per cent, (equivalent to a specific gravity of 1.025).

PROCESSING

Macadamia nuts are processed, on a large scale, in only two parts of the world, namely the Hawaiian Islands and New South Wales, Australia. However, Californian orchards should soon be fully bearing, and it is probable that processing will commence shortly.

Because of the difficulties encountered in producing a product with a good flavour and an acceptable shelf-life, the actual processing details have not been fully

described in the literature. The following account is based on the author's experience of the industry in the Hawaiian Islands and Australia.

The processing of the nuts can be conveniently divided into seven stages — (i) harvesting; (ii) dehusking; (iii) dehydration; (iv) cracking; (v) grading; (vi) roasting and (vii) packaging.

(i) Harvesting the Nuts

The nuts are allowed to fall from the tree when mature. It is important not to pick the nuts from the tree because of the difficulties in distinguishing between immature and mature nuts. In the majority of orchards, the nuts are still picked up by hand, although increasing attention is being paid to mechanisation of this process. With hand harvesting, costs can be reduced significantly by blowing the leaves from under the trees before the pickers go through. The leaves are blown into the inter-row leaving the nuts exposed. In some orchards, where a flat surface allows, mechanical harvesting has been introduced, a harvester originally designed for walnuts and pecan nuts having been adapted for the purpose. For mechanical harvesting to be satisfactory, it is necessary to control excessive weed-growth amongst the trees. Although ever-green, the macadamia continually drops its leaves causing further problems with mechanical harvesting. Funnels of netting to direct the falling nuts to a collection point have also been considered.

It is essential that the nuts are picked up frequently, at least once a week during the peak of the season, and even more frequently during wet weather, otherwise deterioration in the quality of final product will be evident. Damage from rats can also be serious, cases having been reported where over 50 per cent of the crop has been lost in this manner. Wild pigs eating the nuts are also a problem.

When the mature nut falls to the ground, it contains a high percentage of water, 30 per cent in the husk alone, and 25 per cent in the rest of the nut. The moisture in the husks must be removed as quickly as possible to prevent damage by moulds.

The harvested nuts should not be left in boxes to "sweat", otherwise a rapid rise in temperature will occur within the mass, resulting in deterioration. If it is absolutely necessary to hold fresh nuts for a period, it is recommended that the nuts be spread on wire mesh trays, protected from rain, no greater than three inches in depth, and raked over regularly.

(ii) Dehusking the Nuts

When the nuts arrive at the processing plant, the outer green husk is removed as quickly as possible. Various devices have been invented for this purpose, the simplest using revolving rubber wheels. A higher efficiency is said to be obtained using a revolving disc fitted with blades on its flat surface and a static labyrinth above. A rotary wire brush has also been used. Separation of the husks from the nuts is achieved by a blast of air.

Husks are used as a mulch for the soil, and some research has been carried out on utilizing the dried material as an animal feed in a mix with pineapple bran and molasses.

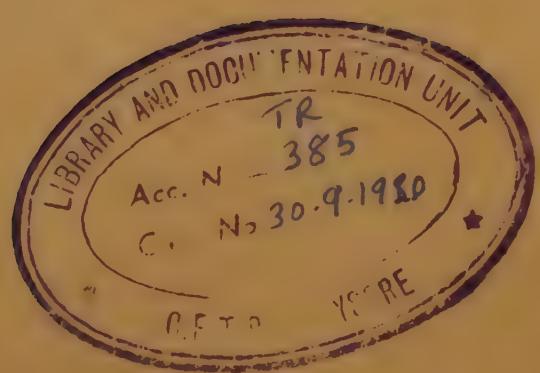
(iii) Dehydration

Dehydration is the most critical step in the processing of macadamia nuts, the actual conditions used by the various processors being kept strictly confidential. It is important that the in-shell moisture content be reduced to 1.5 per cent as soon as possible if flavour deterioration is to be prevented. At the same time, the kernel shrinks away from the shell making the decortication step easier.

In some parts of Hawaii, the nuts are first sun-dried but it is only possible, even under the most favourable conditions, to reduce the moisture content to about

The small-scale manufacture of compound animal feed





Tropical Products Institute

G67

The small-scale manufacture of compound animal feed

R. Palmer-Jones

D. Halliday

This report was produced by the Tropical Products Institute, a British Government organization which helps developing countries to derive greater benefit from their renewable resources.

It specializes in post-harvest problems and will be pleased to answer requests for information and advice. Reports such as this one are often written as the result of an enquiry.

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Introduction

THE SCOPE AND PURPOSE OF THE REPORT

This report is intended to be an investment guide for those interested in the possibility of setting up a plant to process compound animal feedingstuffs. Theoretical aspects of animal nutrition are dealt with in chapter 2, and these are related to the properties of the various raw materials used in feed production in chapter 3. Chapter 4 describes the manufacturing process and examines the physical requirements for setting up plants at various scales of output, and chapter 5 develops cost models for the plants described. Finally chapter 6 examines certain broader economic factors affecting the industry.

Thus the report attempts to deal with all the principal factors relating to the establishment of a compound feedingstuffs industry, and to provide the basis for full feasibility studies. The cost models, which are tabulated in great detail in the appendix, have been expressed both in physical and in financial terms. The former should facilitate the use of the report in a variety of circumstances by enabling the insertion of local data into the models; the latter should give further guidance in that it provides a worked example using known costs for a specific developing country in Asia for which data were available.

Further assistance in the preparation of feasibility studies can be given by the Tropical Products Institute, and, once a positive investment decision has been reached the Institute can supply technical services to help in the setting up and commissioning of a feed mill. Addresses of machinery makers and technical services can be supplied on request.

It should be noted that the report is concerned only with relatively small scale plant, which has been taken to include rates of output from 1 ton per hour to 10 tons per hour. The scales chosen correspond to the lines of machinery available from manufacturers. Plants producing at a rate greater than 10 tons per hour will usually be specifically designed and built for each customer's requirements, and will not consist of the standard units referred to in this report. The report can be adapted to assist in evaluating the feasibility of larger scale plant.

ECONOMIC BACKGROUND TO THE INDUSTRY

In the main the demand for animal feeds is derived from the demand for animal products as human food, and the general pattern is that this demand rises in response to increases in income and population. However, it is difficult to gauge total demand; it cannot be estimated from trade since many compound feeds and their ingredients are not imported into the developing countries on a large scale on account of the high incidence of transport costs, their bulk being great relative to their value. While there appears to have been a rapid rise in the production of compound feeds in a wide variety of countries in recent years, it is likely to be the case that the potential market is much greater, and that there is considerable room for expansion of the industry.

The greatest increase in demand for animal products is likely to come from urban areas where families living above the subsistence level are concentrated, and this demand may be sufficient to justify the setting up of integrated animal production and feed compounding enterprises. Another potential source of demand for compound animal feed occurs where there is a high seasonal mortality among livestock due to scarcities of feedingstuff caused either by snow or drought, and where it is worth feeding animals with compound feeds costing a high proportion of the value of the animal.

One significant obstacle to the more rapid development of demand for compound animal feeds in developing countries is the fact that in many cases the existing animals are of low quality, and have low productivity in the sense that they are not capable of converting inputs in the form of feed into a high ratio of output in the form of saleable meat. In these circumstances it is usually uneconomic to attempt to increase the output of animal products by means of an increased production of expensive, high quality compound feeds alone. The Food and Agriculture Organisation of the United Nations has identified four categories of improvement as being crucial for increasing the productivity of animal husbandry in developing countries. These are:-

1. The improvement of stock through genetic selection, with the particular aim of breeding animals capable of high levels of feed conversion.
2. The use of protective measures against diseases and pests.
3. The adoption of modern feeding practices using balanced rations.
4. The use of feed additives to assist in achieving high feed conversion rates.

Thus any attempt to increase productivity through the production and use of compound feeds should be made as part of a wider program that should also include the development or introduction of new types of animals and new husbandry methods. Since animal products tend to degenerate quickly, a further requirement for the expansion of animal products industries is an efficient system of distribution which will often involve the expense of refrigerated transport and storage. The implementation of the changes suggested requires the deployment of skilled management and labour and the availability of capital.

From the point of view of the supply of compound feeds, the principal cost is that of raw materials which amount to as much as 80 per cent of operating costs in the models described later in the report. Because of high transport costs the tendency will be to use locally available materials, even in locations with good access to external transport. Although many developing countries are food deficit areas, the supply in some countries or areas is moving into surplus largely as a result of the introduction of new high-yielding crop varieties. Some of these countries are now seeking other market outlets for their products in order, among other things, to avert the fall in price and consequent loss of income to producers likely to be caused by a change in the market situation.

Compound feed mills may be linked to a source of supply of raw materials, such as a wheat mill or oilseed crushing plant; to a market outlet, such as a poultry or dairy enterprise; or they may be independent. Traditionally the feed industry has been linked to the supply of the raw materials, as these were generally the by-products of other processes and of low value relative to the main product. However, certain factors have now caused a movement towards market orientation. In the first place, mainly as a result of advances in nutritional science made by firms controlling the raw materials, their value has improved to a very great degree. At the same time nutritional knowledge has become more widespread so that the demand for by-products has increased and their prices have risen, thereby reducing the advantages of supply orientation. Secondly since the distribution system in developing countries is often poor, and since feeds are usually made for particular markets, sales advantages are likely to be gained from market proximity. This will also have the effect of reducing

the size of feed mills compared to those in developed countries. Thirdly, in a situation where there may be a shortage of nutritional expertise, there is an advantage in close contact between animal production enterprises and feed mills. Independent feed mills, which must operate by selling the nutritional knowledge and expertise embodied in their product, are likely to be at a disadvantage in the agricultural conditions of developing countries, and are likely to incur higher costs through their mode of operation.

Principles of scientific animal feeding

FOOD COMPONENTS

The food of animals consists of three major groups of substances : carbohydrates, fats and oils, and proteins, together with smaller amounts of minerals and vitamins, which are essential for the proper functioning of body metabolic processes. In general fats and carbohydrates are the main sources of energy, while proteins and minerals are largely necessary for the building and replenishment of body tissue. The principle of the scientific feeding of farm animals is to obtain optimum yields of meat, milk or eggs by feeding appropriate quantities of rations formulated so as to provide the correct quantities and proportions of these various components.

Carbohydrates

The carbohydrates found in materials used for animal feed fall into three groups:-

1. Soluble sugars such as glucose and sucrose,
2. Storage polysaccharides such as starch,
3. Structural polysaccharides such as cellulose, which form the fibrous structural framework of plants.

The proportions of fibrous carbohydrate and non-fibrous carbohydrate in a feed material are normally described as the percentage of 'crude fibre' and percentage 'nitrogen free extract' (NFE for short), respectively.

Fats and oils

These are important sources of energy in many animal feed materials. Their energy value is particularly high, being 2.25 times that of starch. Fats and oils are glycerides of fatty acids. Some fatty acids are essential for animal metabolic processes, but except for linolenic acid they can be synthesised within the body and it is essential that fats containing this acid be included in rations. All the other fatty acids can be synthesised by animals and are, therefore, non-essential.

Proteins

An adequate supply of protein is essential for the growth and replenishment of animal tissue. This is of particular importance for growing animals, which require a higher percentage of protein in their rations than mature animals.

Proteins consist of chains of substances called alpha amino acids linked to one another. Some twenty amino acids are normally found in proteins, but it is now known that only ten of these are "essential", i.e. sufficient must be present in the ration to meet the minimum nutritional requirements of the animal.

The quality of proteins for nutritional purposes is determined by the proportions of essential amino acids present. Animal proteins are generally of high nutritional value as they contain adequate quantities of all the essential amino acids, but vegetable proteins are normally deficient in one or more essential amino acid, and have a poorer nutritional value than proteins from animal sources.

Early investigations into the composition of proteins indicated that most contained about 16 per cent of nitrogen. This led to the expression of the quantity of protein present in feeds in terms of the total nitrogen present multiplied by a factor of 100/16 i.e. 6.25. The figure for "crude protein" so obtained is not a strictly accurate expression of the true protein content of a feed but is, however, still widely used for comparing the protein contents of feed materials.

Vitamins

Vitamins are substances which act as complements to certain important enzyme systems controlling body metabolic processes. Their ingestion in sufficient quantity is essential, otherwise the body metabolic processes may be seriously disturbed.

Vitamins may be divided into two groups:-

1. Fat soluble – A, D, E and K
2. Water soluble – B group and C

The fat soluble vitamins are generally present in vegetable, animal and fish oils to a greater or lesser extent. Vitamins A and D, are largely present in vegetable oils in the form of precursors which may be converted to the vitamins after ingestion. These precursors are respectively, the carotenes and ergosterol. Vitamin A is essential for the maintenance of healthy mucous membrane, and is particularly plentiful in green vegetable material (as carotene), milk and fish liver oils. Vitamin D is particularly important for the production of skeletal tissue. It is formed from precursors by ultra violet radiation, and if animals are reared under dark conditions deficiency symptoms may develop. As with vitamin A, fish liver oils are good sources of vitamin D. Vitamin E (tocopherol) is particularly necessary for healthy reproduction. Vitamin E is widely distributed in feedingstuffs, cereal germ oils being particularly rich sources. Vitamin K is necessary for the proper functioning of the blood clotting mechanism, and is present in many feedingstuffs.

The compounds forming the water soluble vitamin B complex are particularly necessary for the proper functioning of body metabolic processes and the nervous system. The most important members of the vitamin B complex are thiamine (B1), riboflavin (B2), nicotinic acid (B4) and cyanocobalamin (B12).

Minerals

Minerals constitute about 3–5 per cent of the body weight of animals. The elements present in greatest quantity are those forming the skeletal tissue, i.e. calcium and phosphorus. Sodium, potassium, magnesium, chlorine and sulphur are also important components of body fluids, while iron is a constituent of the haemoglobin. It is important that feed ingested by animals contains sufficient quantities of these elements to meet their bodily requirements, which are obviously greater for young animals which are building new tissue.

Smaller quantities of other elements are also required to ensure the proper functioning of body metabolic processes. Such elements include copper, manganese, cobalt, zinc and molybdenum. Iodine is required as a constituent of the hormone thyroxine produced by the thyroid gland while small quantities of fluorine are present in skeletal tissue.

DIGESTION AND ABSORPTION OF FOOD BY ANIMALS

Digestion and absorption of food by animals occurs in three distinct stages:-

1. The mechanical disintegration of the ingested food by chewing or otherwise into a form suitable for the digestive processes to take place.
2. Conversion of the food components by the digestive juices into simpler compounds e.g. starch to glucose and proteins to amino acids.
3. The absorption of the digested food.

Farm animals can be divided into two distinct groups on the basis of their digestive organs:-

1. Monogastric animals with simple stomachs e.g. pigs and poultry.
2. Ruminant animals with compound stomachs e.g. sheep, cattle and goats.

The digestive tract of monogastric animals with teeth such as pigs, consists of the mouth, the esophagus (gullet), the stomach, the small intestine and the large intestine. Poultry have a similar digestive system but differ in their method of disintegrating the feed. Softer foods are torn up with the beak but harder substances are swallowed whole and stored in the crop, which is an enlargement of the gullet, from which it is passed to an organ called the gizzard where it is ground with the assistance of grit. After mastication by the teeth or in the crop, the food passes through the large and small intestines where it is broken down into amino acids, simple sugars and free fatty acids and absorbed through the intestinal wall. Minerals and vitamins are also absorbed in the small intestine, while undigested material is passed through to the large intestine and subsequently voided as faeces. No digestion of cellulosic material takes place in the small intestine but some may occur due to bacterial action in the large intestine, producing significant amounts of important B group vitamins such as cyanocobalamin. However, the bulk of fibrous material ingested by most monogastric animals is not digested.

Ruminant animals differ from monogastric animals in having compound stomachs consisting of four distinct compartments. The first of these, (the rumen), acts as a vessel for the fermentation of ingested food by micro-organisms (the rumen flora). The rumen flora break down cellulosic plant material and convert it into simple digestible substances.

Nutrients within the plant cells are rendered nutritionally available and a considerable amount of digestible microbial material of high nutritive value built up. The rumen flora can utilise non-essential amino acids and ammonium nitrogen to synthesise all the essential amino acids necessary for building their protein tissue. They can also synthesise the members of the vitamin B group. The ability of the rumen flora to break down cellulose and synthesise essential amino acids and B vitamins, enables ruminant animals to live on rations composed entirely of fibrous materials such as herbage. After about twelve hours in the rumen, the fermented feed is passed successively through the second and third stomachs into the fourth stomach (abomasum) where digestion proceeds as for monogastric animals.

DIGESTIBILITY OF FEEDS

The proportion of each nutrient in a particular feed i.e. crude protein, fat, crude fibre and nitrogen free extract which is absorbed is termed the "Digestibility Coefficient" and is usually fairly constant for animals of the same age and species. However, it does vary to a small extent with individual animals and breeds, and also depends on the other feed components of the ration. Digestibility coefficients must be determined by feeding experiments.

Digestion coefficients may be used to calculate the "Digestible Nutrients" in feeds by multiplying them by total amount of each nutrient present. Figures given in tables for the composition of feed materials in the literature are normally averages of the results of a number of feeding experiments. When using such tables to formulate rations it is important to take into account the type of animal to which the material is to be fed. It is normal to have different tables at least for ruminant and monogastric animals.

ENERGY CONTENT OF FEEDS

The energy value of a feed will vary depending upon the species and age of the animal, and the use to which the energy is put. The energy supplied by a fibrous feed to ruminants will obviously be very different to that which it would supply to pigs and poultry. Also the energy supplied by a feed will depend whether it is used wholly for maintenance or partially for the production of fat, milk or eggs. The assessment of energy values of feeds is particularly difficult for ruminant animals.

The first practical system of assessing the energy value of feeds was in terms of its equivalence to the energy content of the same weight of starch, the "Starch Equivalent" of a feed being defined as the weight in pounds of starch which would supply the same amount of energy for fattening as 100 pounds of feed. In calculating the starch equivalent of feeds from the digestible nutrient content, it is assumed that the starch equivalents of crude protein, fat and carbohydrate (nitrogen free extract and crude fibre) are 94, 240 and 100 respectively. Calculated starch equivalents are not strictly accurate, however, as no account is taken of the energy used for mastication and digestion.

Another similar method of expressing the energy value of feeds was that developed by Morrison, who introduced the concept of "Total Digestible Nutrients" (TDN). The TDN of a feed is defined as the sum of the digestible carbohydrate, digestible crude protein and 2.25 times the digestible crude fat. Both starch equivalents and TDN have been extensively used for calculating energy values particularly in Europe and the USA respectively. However, they suffer from the fundamental defect that even with a single species of animal energy values will depend on the use to which the energy is put.

The modern approach to the assessment of energy values is that of metabolisable energy (ME), which is the amount of energy available for metabolic processes, i.e. the calorific value of the digestible portion of the feed minus that of the urine. The ME values of individual feeds which are expressed as Calories, are constant for particular species of animals of the same maturity and can be used to calculate the apparent ME of the whole ration. The ME of feeds can also be calculated from the digestible nutrients using equations developed by several workers. The ME approach is already in standard use for poultry feed and is likely to gradually replace that of the older systems for other classes of animals.

NUTRITIONAL REQUIREMENTS OF DIFFERENT ANIMALS

Pigs

As pigs are non-ruminant animals they are largely unable to digest cellulosic materials. However, mature pigs such as breeding sows can tolerate rations containing quite high proportions of fibre, for example they often obtain much of their maintenance requirements, the amount and quality of feed which enables them to retain their present weight, by means of grazing. Pigs must also ingest sufficient essential amino acids and B group vitamins in their rations, as these cannot be synthesised within their digestive tracts. The nutrient requirements of pigs vary with their age and other circumstances. For example mature animals such as breeding sows have differing

requirements depending upon whether they are pregnant, lactating or resting between litters, and fattening pigs have different nutrient requirements to growing pigs.

If pigs are weaned early at two to three weeks old, they must be given a diet of very high digestibility with about 30 per cent proteins of high quality. Minerals and vitamins must be added to supplement those present in the other components of the ration. If pigs are weaned at the normal age of eight weeks or so, then from the age of two to three weeks they should be supplied with a supplementary food ("pig creep feed"). This should be similar in properties to the complete feed supplied to early weaned pigs, except that the protein content need be only around 20 per cent (dry basis). After attaining the age of eight weeks, the weaned pigs may be placed on a ration with a protein content of around 18 per cent (dry basis), which may be gradually reduced until at 18 weeks a fattening ration containing only 13 to 14 per cent protein (dry basis) may be fed. Rations for more mature pigs may contain a higher percentage of fibre, and it is customary for additional vitamin requirements to be supplied in the form of dried grass or lucerne. Pregnant and lactating sows require rations containing 16 to 18 per cent of protein (dry basis) respectively.

Chickens

As poultry are monogastric animals they need to ingest all their essential amino acid and nearly all of their vitamin requirements. Poultry have small digestive tracts in comparison with their ability to grow and lay eggs, and thus require feeds of high digestibility with low fibre contents. This is especially so for young chicks. Protein requirements of chickens vary depending on the maturity and other circumstances of the birds. The protein content of the ration of a chick must be around 22 per cent (dry basis) until it reaches the age of eight weeks, after which the protein content can be reduced to 18 per cent (dry basis) for a further ten weeks. The mature breeder or layer requires a ration containing around 16.5 per cent protein (dry basis). For broilers the protein content should be reduced from 22 to 19 per cent after five weeks and kept at this until slaughter at nine weeks. As with pigs, protein quality must be high.

Minerals (particularly calcium and phosphorus) and vitamin supplements are particularly necessary especially for young chicks and layers and breeders. Part of the vitamin requirements are often supplied by the addition of 2.5 to 5.0 per cent of grass or lucerne meal to the ration.

Turkeys

Turkeys have in general more exacting nutritional requirements at the growing stage than chickens especially for protein and vitamins. For example turkey poult require a ration containing around 31 per cent of protein (dry basis) till they are eight weeks old and 22 per cent from then till sixteen weeks. Mature breeding turkeys have protein requirements similar to those of breeding or laying chickens, while turkey broilers slaughtered at sixteen weeks require a ration containing 17.5 per cent of protein (dry basis) from eight to sixteen weeks.

Ducks and geese

Growing ducks and geese have protein requirements which are similar or slightly less than those of chickens, and vitamin requirements similar to those for growing turkeys i.e. greater than those of chickens.

Cattle

Cattle mature enough to have developed rumens do not require supplementary B

group vitamins or high quality protein, but newly-born calves have the same nutritional requirements as monogastric animals. Calves are normally weaned as early as possible at three to five weeks, but their rumens do not develop sufficiently for them to be termed real ruminants until the eighth or ninth weeks. About 10 days after birth, calves are gradually introduced to a highly digestible concentrate weaning feed containing about 17 to 18 per cent of protein (dry basis) with essential minerals and vitamins. This ration is fed after complete weaning until 12 weeks, when it is gradually replaced by a rearing ration suitable for animals with developed rumens. Rearing rations normally consist of a roughage supplemented as far as necessary by a concentrate mix to supply additional protein, energy, minerals, and vitamins (where dry feeding with non-green roughage is employed).

The rations of growing and mature animals with developed rumens can be divided into two parts called respectively the maintenance and production rations. Cattle can largely maintain themselves adequately on a ration of roughage, but when sufficient fresh herbage or other highly nutritious roughage is not available, an additional ration of protein and energy concentrates, minerals and possibly vitamins is necessary to meet extra demands. These demands may be for milk production, the growth of immature animals or fattening for slaughter. Concentrate mixes for these purposes are normally prepared from cereals, oilseed cake and urea with a mineral mix and are tailored to meet the requirements of particular situations. For example a typical winter dairy feed concentrate for temperate climates has a protein content of around 20 per cent, while a spring dairy concentrate would have a protein content some 2 per cent less to allow for the availability of fresh grass of higher protein content.

Sheep

As with calves, lambs do not have developed rumens when they are first born and have the same nutritional requirements of monogastric animals. They are not normally weaned artificially and continue suckling for four to five months, by which time they have well developed rumens. Before final weaning solid food is supplied in the same way as for calves to supplement the ewe's milk "lamb creep feeds".

Concentrate feeds are also supplied to mature sheep and weaned lambs to supplement a basic ration of roughage in the same way for cattle.

Raw materials for compounded feeds

TYPES OF ANIMAL FEED

The materials used for animal feed may be classified into three groups:-

1. Roughages: bulky fibrous materials either fresh, dried or ensiled, mainly suitable for feeding to ruminant animals.
2. Concentrates: non-fibrous starchy or proteinaceous materials suitable for feeding to all types of animals.
3. Supplements: essential minerals and vitamins, and medicaments which maintain animal health and ensure satisfactory feed conversion.

There are some materials which cannot strictly be called either concentrates or roughages; for example, molassed dried sugar beet pulp and lucerne (alfalfa) meal, but in general this is a fairly valid and distinct classification, which is widely used in animal husbandry.

The materials mostly used for animal feed compounding are the concentrates with various supplements. It is, however, fairly standard practice to include from 2.5 to 5 per cent of dried grass or lucerne meal in compounded feeds for both monogastric and ruminant animals. Compounded feeds are generally produced either as a complete feed for monogastric animals or immature ruminants, or as a supplementary concentrate feed both for ruminants on a basal ration of roughage, and for monogastric animals on a basal energy ration of cereals or starchy roots.

Concentrates used for animal feed compounding may be classified under six headings:-

1. Cereals and their by-products (wheat, barley, oats, rye, maize, sorghum, millet, rice etc).
2. Pulses (peas and beans).
3. Residues from oilseeds after oil extraction (soya, groundnuts, linseed, cotton-seed, rape-seed, mustard-seed, kapok seed, palm kernels, coconuts, sesame, sunflower seed etc).
4. Dried starchy roots and tubers (cassava, potatoes etc).
5. Animal and fish products and by-products (meat, bone and blood meals, fish meal, dried fish solubles, dried milk products etc).
6. Miscellaneous materials (grass and lucerne meals, dried sugar beet pulp, molasses, carobs, etc).

Cereals and their by-products

Cereals normally provide most of the energy content of compound feeds. They are generally low in crude fibre content and high in starch and are therefore particularly

useful for inclusion in feeds for monogastric animals.

The crude protein content of the cereals most commonly used for feed compounding, namely barley, wheat, sorghum and maize is normally within the range of 9 to 12 per cent. Growing monogastric animals require larger proportions of protein in their rations than would be supplied by cereals alone, but cereals may often supply most of the protein requirements of mature animals. The essential amino acid make-up of cereal proteins is too unbalanced to satisfy the dietary requirements of most monogastric animals. Cereal proteins tend to be particularly deficient in lysine and methionine, while maize protein is also markedly deficient in tryptophan.

The mineral content of cereals is low and they are incapable of supplying the mineral requirements of livestock.

Cereals, with the exception of yellow maize, have little vitamin A activity and contain no vitamin D. They are generally deficient in riboflavin and vitamin B12, but, except for maize, contain sufficient nicotinic acid to largely meet the dietary requirements of monogastric animals.

Most of the minerals and vitamins of cereals are concentrated in the testa and germ, one or both of which are largely removed during processing prior to human consumption. The offals of these operations are valuable feed materials being richer than their parent grains in vitamins, minerals, oil and protein, but also contain higher percentages of crude fibre than unmilled cereals. Similar offals are obtained from the brewing, starch and glucose industries.

Typical values for the composition of cereals and cereal by-products which are or could be used for animal feed compounding are given in Appendix 1. Typical values for the vitamin and mineral contents of some of the materials listed in Table 1 are given in Tables 7 and 8 respectively. The essential amino acid contents of the proteins of some more important cereals are given in Table 9.

Pulses

Pulses are grain legumes commonly described as peas or beans. They generally contain just over 20 per cent of crude protein, are rich in starch, low in oil and do not contain too high a percentage of crude fibre. These characteristics make them eminently suitable for feeding to monogastric animals as protein supplements. A list of the more common pulses and their compositions is given in Table 2 of Appendix 1.

Pulses like cereals (other than yellow maize) have little or no vitamin A or D activity. They are richer in riboflavin than cereals but also contain no vitamin B12. The nicotinic acid and thiamine contents of pulses are similar to those of cereals, and they are also rather richer in minerals. Figures for the vitamin and mineral contents of some pulses are given in Tables 7 and 8 Appendix 1 respectively.

The protein of pulses is richer in lysine than cereals but deficient in methionine. Figures for the amino acid composition of pulse protein are given in Table 9 of Appendix 1.

Oilseed residues

The residues remaining after expulsion ("expeller cake") or extraction ("extracted meal") of the oil from oilseeds are very important for animal feed compounding. Typical values for the composition of residues from the more important oilseeds are given in Table 3 of Appendix 1.

It will be seen that the crude protein contents of oilseed residues are mainly within

the range of from 20 to 50 per cent. For those oilseeds with fibrous husks e.g. cottonseed, groundnuts and sunflower seed, the protein content of the residues is greater if the seeds are decorticated before the oil is removed. Oilseed residues of high protein content such as groundnut, soya, and cottonseed are widely used as protein supplements. Their use for this purpose may, however, be limited by crude fibre content, amino acid composition and the possible presence of toxic factors.

The crude fibre content of oilseed residues may depend on the state in which the seeds were crushed or extracted, and cottonseed, groundnuts and sunflower seed crushed after decortication yields cake with a much lower crude fibre content than that prepared from un-decorticated seed. Oilseed residues of high crude fibre content cannot be included in high proportions in feeds for non-ruminant animals. Oilseed proteins generally contain adequate proportions of lysine but are invariably deficient in methionine and cystine. This limits their usefulness as protein supplements for non-ruminant animals, and it is normally necessary to add them in conjunction with high protein materials of animal origin to correct these deficiencies. The amino acid contents of some oilseed proteins are given in Table 9 of Appendix 1.

Oilseeds may contain a number of toxic substances which may pass unaltered into the cake or meal. These substances may be natural constituents of the seeds such as gossypol (cottonseed), linamarin (linseed), ricin (castor seed), and the anti-nutritional substances in soya beans, or toxic mould metabolites such as aflatoxin which may be formed if the seeds are allowed to become mouldy before processing. Naturally occurring toxic substances may be wholly or partially eliminated during processing but some materials such as cottonseed cake and detoxified castor seed cake should not normally be included in feeds for non-ruminant animals.

Toxicity due to moulds is a general problem affecting feed materials of vegetable origin, but is particularly serious for residues of oilseeds originating in tropical or sub-tropical areas. The commonest toxic mould metabolite is aflatoxin which is produced by strains of the mould *Aspergillus flavus*, which is not destroyed during oilseed processing and is widely present in cake and meal produced from groundnuts and palm kernels. Aflatoxin is especially toxic to very young animals, and the use of materials which may contain aflatoxin in feeds compounded for immature animals should be severely restricted. It is also very important that raw materials or compounded feeds are not allowed to become mouldy during storage, as otherwise they could become toxic.

Oilseed residues like cereals and pulses contain only negligible amounts of vitamin A active materials, vitamin D and vitamin B12. Their content of other B group vitamins is rather higher than that of pulses. Typical values for the vitamin contents of some oilseed residues are given in Table 7, Appendix 1. The mineral content of oilseed residues is generally about twice that of pulses (see Table 8, Appendix 1.).

Dried starchy roots and tubers

Starchy roots and tubers such as potatoes, cassava, yams, sweet potatoes etc. cannot be used in compounded feeds unless they are dried to a moisture content of 15 per cent or less. They are rich in starchy carbohydrate, low in crude fibre, minerals and vitamins, and mostly have crude protein contents below those of cereals. Dried cassava is the only material of this type at present used to any great extent in animal feed compounding, and is included solely as a source of easily digestible energy. Other dried roots of higher protein content such as potatoes and yams could however, make more useful contributions to the protein content of the compound feed. The composition of some dried roots and tubers is given in Table 4 of Appendix 1.

Animal and fish products and by-products

Animal by-products used as feed materials normally result from the operations of

abattoirs for cattle, sheep and pigs, and plants for the slaughter and dressing of poultry.

The material processed into animal feed at abattoirs consists of the non-edible portions of the carcase (other than the hide) such as blood, bones, trimmings, gall bladder, hoofs, etc., together with whole carcases which are considered unfit for human consumption. These materials are rendered down (unnecessary in the case of blood), sterilised, dried, and milled into meals suitable for animal feeding. These meals vary in composition depending upon the material processed. There are, however, four general types available:-

1. Blood meal: prepared from blood only and consisting almost entirely of protein.
2. Meat meals: prepared from materials containing little or no bone.
3. Meat and bone meals: prepared from abattoir by-products including bones.
4. Bone meals: prepared mainly from bones.

The crude protein content decreases progressively from 86 per cent for blood meal to less than 25 per cent for bone meal, while the mineral matter content progressively increases from 2.7 per cent for blood meal to 60 per cent or more for bone meal. The composition of bone meal depends upon the treatment during processing, in that steaming and solvent extraction will reduce the proportion of non-mineral material present. Typical figures for the composition of these various blood, meat and bone meals are given in Table 5 of Appendix 1.

Feed meals can also be prepared from non-edible waste from poultry operations. The raw materials for those feeds are obtained from hatcheries and plants for the slaughter and dressing of poultry. Inedible material is rendered, dried and milled in the same way as abattoir by-products, and marketed under the name of "poultry by-product meal". Meals can also be prepared from sterile eggs, etc. in hatcheries. Feathers can be converted into "feather meal" by treatment with steam under pressure, followed by drying and milling. Typical values for the composition of these feed materials from poultry waste can be seen in Table 5 of Appendix 1.

Another important group of feed materials of animal origin are derived from milk. The two products most commonly used are dried skimmed milk and dried whey (see Table 5, Appendix 1 for composition).

The last and possibly most important group of feed materials of animal origin, are those derived from fish. Fishmeals are produced by the rendering, drying and milling of inedible waste from fish processing or from whole fish which are unsuitable for human consumption. The oil is often extracted from fishmeal by solvents before it is marketed as an animal feed. Fishmeals are rich in both protein and mineral matter. Other fish by-products of value as a feed material are the so-called "fish solubles" formed by condensing and drying the watery waste from fish processing, which are higher in protein and lower in mineral matter than fish meals. Typical values for the composition of animal feeds derived from fish are given in Table 5 of Appendix 1.

Meat, blood, poultry by-products and fish meals, and milk powder are particularly valuable for inclusion in feeds for immature monogastric animals, as their protein is of a higher biological value than vegetable proteins, which are usually deficient in one or other of the essential amino acids, lysine, methionine or tryptophan. Feather meal is, however, a poor source of these amino acids but has a high cystine content. Typical values for the essential amino acid contents of these materials are given in Table 9 of Appendix 1.

Fishmeal, meat and bone meal, bone meal and poultry by-products are also good sources of minerals (particularly calcium and phosphorus). They are also together

with milk and whey powder, good sources of vitamin B12 and riboflavin in which concentrates of vegetable origin (other than micro-organisms like yeast) are largely deficient. Typical values for the vitamin and mineral contents of feeds of animal origin are given in Tables 7 and 8 of Appendix 1 respectively.

Miscellaneous materials

There are a number of miscellaneous materials which are suitable for the manufacture of compounded feeds. Typical values for the compositions of the more important of these are given in Table 6 of Appendix 1.

The first group of substances comprises the by-products of the beet and cane sugar industries. Molasses is the most important of these, and is particularly used as a binder for pelleted feeds. Its nutritional value is almost entirely as a source of energy, but the extent to which it can be incorporated in feeds is restricted by its high potassium content, which can cause digestive disturbances. Dried beet pulp with or without added molasses has too high a crude fibre content for use in feeds for monogastric animals, but is useful as an energy source for feeds for ruminant animals.

Carobs (*Ceratonia siliqua*) and their tropical counterpart the African locust bean (*Parkia* spp.) consist of a number of hard seeds inside a fleshy pod. The pods are useful as an ingredient of compounded feeds due to their high sucrose content (about 20 per cent) and pleasant flavour, but contain little protein. The seeds contain more protein than the pods and can be usefully included in compounded feeds both as a protein and energy source.

Grass and lucerne meals are incorporated in small quantities in a wide range of feeds for monogastric animals despite their high fibre contents, because they are a rich source of vitamin A active compounds, vitamin E and B group vitamins other than B12. They are also rich in minerals such as calcium. Grass and lucerne meals contain large quantities of xanthophylls which impart a permanent yellow colour to egg yolks and the subcutaneous fat of poultry, which is desirable in many markets for poultry products. The protein content of grass and lucerne meals is also a useful 15 – 20 per cent, but like most vegetable proteins they tend to be deficient in the essential amino acid methionine.

Yeasts are valuable animal feed materials as they contain 40 – 50 per cent of crude protein and are also a rich source of all B group vitamins, with the exception of B12. However, a large proportion of the nitrogen of yeasts is present as nucleic acids, which do not contribute to the actual protein status. Yeasts have a strong flavour and may cause gastric disturbances if fed in large quantity. These factors limit the amount which can normally be included in compounded feeds. True proteins of yeast contain adequate quantities of lysine but are generally deficient in methionine (see Table 9, Appendix 1).

Lastly sago flour (prepared from the pith of the sago palm, *Metroxylon sago*, which is cultivated in Malaysia and Indonesia) should be mentioned as a possible animal feed material. Sago flour consists almost entirely of starch and is of use only as an energy source.

Mineral, vitamin, amino acid and antibiotic supplements

In addition to the materials mentioned above, it is common practice to add minerals such as calcium carbonate, sodium chloride etc. to compounded feeds. Additional vitamins A and D may also be supplied by the inclusion of fish liver oils, which are particularly rich in those vitamins, or as synthetic and extracted vitamin concentrates in powder forms.

Pure lysine and methionine are now often added to compounded feeds to correct the deficiencies of the proteins present. Various antibiotics are also added to feeds for monogastric animals (particularly poultry broilers) to stimulate growth and reduce the possibilities of disease.

Minerals, vitamins, amino acids and antibiotics are normally added in the form of a single pre-mix to ensure adequate distribution throughout the feed.

SUMMARY OF MAIN TYPES OF COMPOUNDED FEEDS NORMALLY PRODUCED

Poultry, ducks and turkeys

There are three main types of feed normally produced:-

- (a) Chick, turkey poult and duckling starter feeds: these are fed for the first 6 to 8 weeks after hatching, to birds it is intended to rear to maturity.
- (b) Grower feeds: birds are placed on this feed from starter feeds until they reach 16 to 18 weeks.
- (c) Breeder (layer) feeds: these are for mature birds over 16 to 18 weeks old retained for egg production.
- (d) Broiler feeds: there are feeds for broilers for which the intention is to cause the maximum weight gain until nine weeks after hatching, when the birds are slaughtered. Broiler feeds normally consist of starters for birds under 5 weeks and finishers for those of 5 weeks and over.

Poultry, ducks and turkeys need a concentrated diet of low fibre and high protein content containing relatively large amounts of minerals and vitamins. Typical formulations of feeds of the above types from a variety of materials are given in the selected bibliography given as Appendix 4. Normally they consist of 75 to 80 per cent cereal and cereal products mixed with 5 to 10 per cent of meat or fish meal and 5 to 10 per cent of an oilseed cake or extracted meal but this is dependent on the local prices of suitable materials. About 5 per cent of vitamins/mineral supplement mixture is also added. A small quantity of fat (2½ to 5 per cent) is added to broiler feeds. The requirement for protein decreases with increasing maturity of the bird.

The cereals most commonly used are maize, barley and sorghum, while soya-meal is the oil seed meal most suitable, due to its low fibre and high lysine content.

Pigs

Compounded feeds for pigs may be classified into six main types:-

1. Complete starter feeds for early weaned piglets (2 to 3 weeks old).
2. Supplementary feeds "creep feeds" for piglets from three weeks after birth until they are fully weaned at 8 weeks.
3. Feeds for lactating sows and weaners.
4. Growing feeds for the period while the pig is still immature (up to about 50 to 60 kg liveweight).
5. Bacon feeds.
6. Final fattening feeds.
7. Special feeds for pregnant sows.

Compounded feeds for the more mature animals may be in the form of concentrates to supplement a basal energy ration of such materials as cooked starchy roots, in addition to complete feeds.

The materials normally used for compounded feeds are similar to those used for poultry feeds, except that increased use may be made of the more fibrous cereals and oil-seed residues in feeds for more mature animals. A typical creep-feed could contain about 83 per cent of cereal and cereal by-products with 15 per cent of fish meal and dried milk and 2 per cent of minerals and vitamin pre-mix. A complete fattening feed may contain 95 per cent cereals and cereal by-products with 3 per cent of grass or lucerne meal and 2 per cent of minerals.

Cattle

Cattle feeds are of two types:-

1. Those for calves before their rumens start to function effectively.
2. Those for cattle with functioning rumens.

The first type of feed are similar in composition to pig creep and starter feeds and must be low in fibre and contain all the nutrients necessary for growth, with the exception of those in the mother's milk which they may also receive.

The second type of feeds are those designed to supplement the basal ration of roughage normally fed to cattle with functioning rumens. This supplementation may be necessary to supply additional nutrients for growth, maintenance, milk production pregnancy, or fattening, and suitable feeds are formulated for these various purposes. As ruminants can synthesise their essential amino acid and can digest cellulosic fibre, protein is normally supplied as the more fibrous oilseed residues e.g. coconut, cottonseed and groundnut cake. It is also not necessary to add vitamin supplements, but 5 per cent of minerals are normally included.

A typical concentrate feed for milk production ("dairy feed") designed for feeding as a supplement to a ration of dry roughage might include 45 per cent of cereals and cereal by-products, 40 per cent of oilcake, 5 per cent of grass meal (to provide vitamin A), 5 per cent of carobs and 5 per cent of minerals. Concentrates for feeding as supplements to green roughages would not need quite so much protein or a source of vitamin A, and would contain no dried grass and less oil cake. Ruminants are able to synthesise protein from non-protein nitrogen and it is now common practice to replace part of the protein supplied as oil cake by the addition of urea.

Sheep feeds

The same considerations for the formulation of cattle feeds apply to sheep feeds. As with cattle feed there are those feeds (starter and creep feeds) designed for lambs with undeveloped rumens and those concentrate feeds for supplementation of basal rations of roughage. The compositions of these various types of feeds for sheep are generally similar to those of their equivalents designed for cattle.

FORM OF SUPPLY OF COMPOUNDED FEEDS

Compounded feeds may be supplied either as ground meals or pellets. In general cubes or pellets of appropriate size for the animals which they are to be fed are the most convenient method of supply, as they are easier to handle and feed to stock, pelleting also ensures against possible segregation of components before

feeding. Pellets are, however, more expensive to produce than ground meals.

In the production of pellets it may be necessary to use a binder such as molasses, and if supplies of suitable binding materials are not conveniently available it may not be practicable to produce pellets. Also the output of small mills may be insufficient to justify the installation of pelleting or cubing machinery.

It is thought that another disadvantage of pelleted feeds may be that since birds can obtain their food requirements in a shorter time than from meal, they will expend their surplus time and energies in feather picking and other undesirable activities.

Outline of the manufacturing process

INTRODUCTION

The operations necessary for the manufacture of compound animal feeds are explained in this chapter in sequence. However, since they are not all performed by all feed mills, and since it is possible to change the order of operation in some cases, possible deviations from the sequence have been indicated. The processes described relate to the cost models developed in chapter 5, which are broadly similar. Where differences in production methods arise between the models they are noted in this chapter, and can be seen by reference to the drawings in Appendix 2.

THE PROCESS

Reception

In developing countries raw materials will usually arrive at the factory in sacks, which can be either manhandled or conveyed mechanically into the warehouse. No provision has been made in the cost models for sophisticated handling equipment. Since quality control is an important part of feed compounding, checks should be made on the weight and condition of the incoming raw materials, and samples should be taken for laboratory analysis, where possible.

Drying and cleaning

At the small scales of operation described, mills will not usually find the provision of special equipment for cleaning and drying the raw material worthwhile. Losses due to damp, dirt and contamination can be avoided by the use of suitable storage techniques.

Storage of raw materials

Incoming raw materials should be stored under conditions which ensure that they are kept dry and free from insect and rodent pests. If they are to be stored in bags they should be kept in a produce warehouse constructed to an appropriate standard. The warehouse should have a concrete floor but the roof and walls need only be lightly constructed, provided of course that they are pest and water proof. As a rough guide to the space requirements, 6 square feet per ton of stored material is allowed in the models. The amount stored will vary from time to time since storage can be used to even out fluctuations in the supply of individual ingredients, and allows advantage to be taken of price fluctuations.

Raw materials may also be bulk-stored, either in silos constructed from concrete or steel, or in bins formed with partitions in conventional stores. In general bulk storage entails a greater investment in capital equipment, but lower operating costs. Working

capital which would be tied up in the bags used to contain the raw materials is also released. The particular method chosen for raw material storage will depend on the local circumstances, but in areas where labour is cheap and plentiful and capital funds scarce, it is likely that storage in bags will be preferable.

Grinding

Some materials, including cereals and oilseed cakes, need grinding to prepare them for blending and/or mixing. In some mills (models II and III) materials are first blended, then ground before mixing; in other mills (models I and IV) they are ground first, then blended and mixed. In all the models the raw materials, blended or single, are fed into an elevator which feeds a grinder bin. The outlet of this bin incorporates a magnetic trap and a vibrating feed which regulates the flow of material into the grinder so that the load on the grinder motor is kept at its optimum level.

All the grinders are hammer mills, also known as impact grinders. These are the most suitable type available at the present for use in feed compounding. The other common types, disc grinders and roller grinders, have their own applications but are not usual in feed mills. Both have a higher capital cost than hammer mills of similar capacity and produce products with qualities that hammer mills cannot achieve.

The working of a hammer mill is illustrated in figure 1, p. 43. The material enters a chamber in which a set of beaters revolves, driven by an electric motor. The beaters throw the material against projections on the inner surface of the chamber, which break up the material, and against a perforated screen through which the ground material passes. Wear on the beaters, projections and screen is slight but they can be damaged by foreign bodies such as stones, glass or metal objects entering the grinding chamber.

After the material has passed through the screen it is blown through a pipe into a cyclone which collects the ground material.

Certain mixtures of air and dust created by the grinders are explosive, especially when, as in a grinder, there is a risk of sparks. Because of the dangers of explosion, the grinders are contained in special structures either above or below ground.

The size and capacity of grinder required depends on the amount of material to be ground, the fineness of grind required and the amount of time the grinder can be kept supplied with material. These matters are illustrated in the models in chapter 5.

Ground cereals and some other materials, for instance brewers grains, do not flow easily from blending bins by gravity alone. Therefore, in plants II and III, the raw materials used in large quantities (which are in most cases cereals and oilseed cakes) are blended before being ground. This system results in some raw materials used in large quantities being ground although they do not need it, which, in turn means using a grinder of larger capacity than would otherwise be necessary. Also because of the delay involved in blending batches, the operation of the grinder is interrupted both between batches and when the formulation of batches changes, especially as it is necessary to clean the grinder before using a different formulation. This means that the grinder is working for shorter periods and must be bigger to compensate for this.

In plant IV the grinder is placed before the blending section and ground products are mechanically blended, using mechanical bin discharges which obviate the problems of blending ground materials. Since, therefore, only those materials which require it are ground and the interruptions to the grinder are less than when pre-blended materials are used, the grinder is smaller, saving inconvenience and expense. This, however, must be weighed against the cost of a more expensive blending system.

Blending

Blending involves the assembling and measuring out of the required quantities of raw materials. In model I the raw materials are brought manually from the warehouse and weighed out in batches. Those which need grinding are tipped into the foot of the elevator which feeds the grinder bin, the other materials are tipped into the base of the mixer.

Blending in models II, III and IV is semi-mechanical. In models II and III materials used in large quantities are elevated into one of the four bulk bins. An operative determines which bin is filled by means of a four-way switch. The material flows out of the bins under gravity into one of two batch weighers, the flow being controlled by an operative who opens and closes a flap in response to readings from a dial which registers the amount of material in the weigher. The weight of each raw material in any batch, and the number of batches in each formulation is predetermined. When a batch is complete it is elevated to the grinder bin and ground (see previous section).

In plant IV materials which have been ground fall from the grinder cyclone into the foot of an elevator, other materials are tipped in by hand. One raw material at a time is elevated into a conveyor which feeds six blending bins by means of chutes operated electrically from ground level. Bins are emptied by single-worm dischargers, controlled from a board of switches, which feed a batch weigher. An operative controls the flow from each bin to make up the batch by referring to a dial weight gauge.

After a batch is complete in the weigher it is released into a bin from which it is conveyed and elevated to the mixing section. Materials, like minerals, vitamins and protein supplements, which are required in small quantities, are added in pre-weighed amounts by hand to the bin under the batch weigher.

Mixing

In plants I, II and III vertical mixers are used to mix the blended materials. In plant I ground materials are blown straight into the mixer. In plants II and III all materials are fed into the base of the mixer. Ground materials fall by gravity from the cyclone, others such as vitamins etc. are tipped in by hand. A central screw elevator lifts the material from the tip-in to the mixing chamber, where an even mix is produced in about 15 minutes, generally by means of a revolving paddle. After mixing is complete the machinery is stopped. In plant I the mix either falls from one outlet into an elevator which feeds the pelleter bin, or from a second which is used to fill sacks directly. In plants II and III the mixer falls into the foot of an elevator which feeds either a 'sack-off' bin or the pelleter bin. When one batch is emptied from the mixer the cycle can start again.

In plant IV a horizontal mixer is employed. The blended material is elevated into a buffer bin which empties rapidly into a horizontal mixer underneath. After mixing the material empties into another buffer bin, and is then elevated to either a 'sack off' or a pelleter bin. The mixer is stopped while it is filled and emptied, and the complete cycle takes about eight minutes.

Pelleting

Pelleting is a process that can often be omitted in developing countries, since in many circumstances the costs involved will outweigh any consequent benefits. In all models, the mixed meal falls from the pelleting bin over a magnet, which separates out any iron objects, and is then fed continuously into the conditioner by a vibratory feed, which regulates the flow according to the load on the pelleter motor. In the conditioner steam and molasses as required are continuously mixed with the meal. The quantity of molasses is metered out into the conditioner by a variable speed pump and recorded

on a gauge. The conditioned meal then falls into the pelleter which extrudes the meal through a die. The pellets emerge at the bottom of the pelleter.

In plant I the pellets are elevated into a bin through which air is drawn by a fan to cool the pellets. In plants II and III after elevation the pellets fall down a cooling tower through a fan-induced draught. They are then re-elevated, sifted to get rid of dust and undersized pellets which fall back into the pelleter bin, and dropped into a bin ready for bagging.

In plant I the hot pellets fall from the pelleter into a horizontal cooler. This is a slowly-moving, endless, perforated belt, through which air is drawn by a fan. The pellets are cooled as the belt moves along then fall off the end of the belt and are elevated to a sifter, whence they fall into a bin and are ready to be bagged.

Bagging

Compound feeds are distributed in sacks. In plant I an attachment at the bottom of the ventilated bin controls the flow of the pellets into a sack which is clamped on to the bin. The amount that comes from the bin is controlled by the operative who also removes and replaces the sacks.

In plants II, III and IV, the amount of pellets falling into the sack is automatically controlled. The required weight falls from the bin into a weigher to which the sack is attached. The operative releases the pre-weighed amount into the sack by pressing a lever with his foot. He then removes the sack and, while he is replacing it, the weigher fills.

Storage and distribution of finished compounded feeds

It is undesirable to store finished compounded feeds for long periods, due to the possibility of damage by moulds or insect and rodent pests. A stock of products kept to meet day to day fluctuations in demand should be kept in a warehouse like that used to store the raw materials.

Because the consumers of compound feeds tend to be widely scattered, distribution is an important part of feed milling. Since, however, the circumstances of each mill will be unique, no generalizations which could be incorporated in a model of distribution have been made.

OTHER REQUIREMENTS

For the successful manufacture of compound feeds several other requirements must be fulfilled, and these are discussed below.

Buildings

The building to house the manufacturing plant will depend to a large extent on the particular circumstances of the mill, however, in general the building must be capable of being kept clean, and provision should be made for keeping the dust level as low as possible since it can affect the operation of machinery.

In most environments equipment should be totally enclosed in a light structure; where the climate is suitable, however, the machinery can stand in the open as it sometimes does. A concrete floor, which can be swept, is usual, but should be laid down to the manufacturer's plans as some pits and foundations are required. The machinery has its own supports which are supplied by the manufacturer or can be made locally to his specifications.

Services

Steam boilers are required in most cases where pelleting is performed. Although dry pelleting is possible, the running costs are much higher than when steam is provided.

Water is required only for steam raising, though exceptionally it is also used to sprinkle raw materials before grinding or after mixing.

An electricity supply is necessary and in the absence of a public supply a generating plant would be required.

Hygiene

The standards of hygiene required of a feed mill are not as exacting as those required for foodstuffs for human consumption, and in some feed mills very little attention is paid to this subject. It is, however, important to prevent contamination by rodent droppings, insects, bacteria and fungi etc, because this can lead to disease in the animals, reduce the productivity of the feed and lower the saleability of the product. Most of the cleaning does not involve complicated procedures and this can be fitted easily into the normal working routine.

Quality control

Before materials are used for animal feed compounding it is essential that routine analyses be carried out to determine their approximate composition. For bulk constituents such as cereals, pulses and oilseed residues, meat and fish meals, dried grass meal etc. it is desirable to determine the crude protein, crude fibre, moisture and ash content of each consignment to ensure that they are of the normal quality. Materials which are included to provide additional vitamins and minerals e.g. dried grass meal, bone meal, etc. should also be tested from time to time to ensure that they are of the required standard.

Protein concentrates which have undergone processing, e.g. oilseed cake and meal, and animal by-product meals, which are to be included in feeds for monogastric animals, should be tested to ensure that the quality of the protein has not been reduced during processing. The most important form of damage recognised is the rendering of a proportion of lysine unavailable for nutritional processes by excessive heating during processing. It is, therefore, important to test materials of this type in common usage for "available lysine content" from time to time, and to check any new materials which are offered.

Materials such as cottonseed cake, which are prepared from seeds known to contain toxic substances (gossypol in the case of cottonseed), should be tested to ensure that they are of acceptably low toxicity for inclusion in feeds for the class of animal for which they are intended. For example cottonseed cake should not be included in feeds for pigs or poultry unless the free gossypol content is very low, whereas gossypol tolerance of mature ruminants is very much greater.

All vegetable compound feed materials of tropical origin are liable to contamination with the toxic mould metabolite aflatoxin, produced by strains of the mould *Aspergillus flavus*. Any materials which are suspected of being mould contaminated should be examined for aflatoxin content. Oilseeds such as groundnuts and palm kernels are particularly liable to be contaminated with aflatoxin and cakes and meals should be tested for aflatoxin content as a matter of routine, if they are intended for incorporation in feeds for immature animals. Mature animals have a greater tolerance to aflatoxin, and material to be incorporated in their feeds need not be tested so frequently, if they are obtained from a reliable source.

It is important to ensure that processed materials particularly those of animal origin such as fish, meat and bone meal do not contain any pathogenic bacteria which could cause diseases in animals to which they are fed. The most common pathogenic organism encountered is *salmonella*, and it is important that consignments (particularly from new suppliers) of processed materials be tested for this organism.

References to publications containing standard methods for carrying out the above-mentioned analyses are given in the bibliography at the conclusion of this report.

Laboratory facilities for these chemical analyses, except for the simpler tests, are expensive and require skilled manpower. Small scale feed mills will find it more economic to obtain such analyses from firms of chemical or agricultural analysts, from the government chemist, or from firms which supply mineral, vitamin and other supplements to the feed industry. These latter institutions will usually be willing to calculate least-cost formulations, based on the raw materials they analyse, and recommend supplements for these formulations.

Routine testing is important if a brand-image of the product is to be built up and in some countries it is necessary to comply with legal requirements. Tests on products are designed to ensure that the quality of the product is maintained and that it is free from dangerous levels of contaminants. It is also necessary to check that unexpected changes to the raw materials, during storage and processing, have not occurred. These tests will involve not only the laboratory analysis listed above but also animal feeding trials. These are the crucial tests of the value of a food, since chemical analysis is not yet entirely able to determine the value of a feed. Chemical analysis is used because it is quicker and cheaper than animal feeding tests, requiring less time, equipment and feed.

The design of the cost models

INTRODUCTION

This chapter is mainly concerned with examining the assumptions made in constructing the cost models used to illustrate the economics of small-scale production of compound animal feed. The four different scales of output used in the models are summarised in Table 5.1, and the detailed cost and operational data relating to these models can be found in the tables of appendix 3. The manufacturing process is explained in chapter 4, and the flow charts and diagrams of the processes are shown in appendix 2.

Table 5:1 Output and capital costs of the models used in the report

Model No.	Output per hour ⁽¹⁾ Tons	Approximate yearly output in 300 x 8hr shifts per annum Tons	Total Capital Requirements ⁽²⁾ £UK 1970
I	1	2,400	42,096
II	2.5	6,000	105,213
III	5	10,500 ⁽³⁾	168,236
IV	8	16,800 ⁽³⁾	254,518

Footnotes: (1) All tons in this chapter are long tons of 2,240 lbs each
 (2) Includes plant and equipment, buildings and working capital
 (3) Only 7 hours actual working time per day

SCALES OF PRODUCTION

The upper scale limit was chosen since plant above this level of output is generally custom built. In fact most manufacturers are prepared to design and build special small-scale plant down to levels of output of about 2.5 tons per hour. Moreover a wide range of alternatives to the basic packaged plants described in this report are available to suit individual requirements, though less standardised plant is more expensive than the standard units. Since both the industry and the machinery available are so diverse, only the most basic types of plant are discussed here.

Plants designed to produce at scales less than one ton per hour are usually for only intermittent use as in on-the-farm type equipment. These machines are of less robust construction than the process equipment used in the plants costed here, and used in the feed milling industry. However, this type of machinery might be useful on individual large farms, or in small co-operatives, where the demand does not warrant the output of even a one ton per hour plant. A grinder of capacity between $\frac{1}{4}$ and $\frac{1}{2}$ ton per hour with an electric motor of 5 horse power costs about £200 f.o.b. UK port, one with 10 horse power motor costs about £350.

A vertical mixer, for this type of operation with a capacity of $\frac{1}{2}$ ton, together with a 1 horse power motor, which can be loaded from the ground, costs about £200. A combined mill and mixer costs between £400 and £1,000 depending on the size

of the mixer and the power of the motor which drives the grinder.

A small pelleter capable of making up to $\frac{1}{2}$ ton of pellets per hour, without provision for steam or molasses, costs about £500 without spares and accessories. Dies for these machines cost between £25 and £100 (f.o.b. UK port).

All these machines are of simple construction requiring no skilled maintenance. Spares are standardised and readily available.

PLANT CAPACITY

In models I and II it is assumed that the plant will operate at full capacity during each shift, since it is assumed that working hours are staggered so that the start-up and shut-down operations can be performed before the main shift begins or after it ends. Stoppages during operation will only occur when a machine breaks down. Since it is assumed that only one type of feed will be produced in these plants, (see section "The Products" below), no stoppage is required between batches to prevent contamination, and changes in formulation can be made between shifts.

Models III and IV are assumed to operate at 87.5 per cent of their rated capacity during each shift, i.e. seven hours in every eight. This reduced efficiency results from the necessity to change formulations during the shift, and to prevent the cross contamination of different batches.

In practice, feed mills may have greater margins of unutilised capacity, especially during the first years of operation when sales are being built up. Common levels of operation in the U.K. of larger feed mills are about 75 per cent of capacity. In part, this is due to the seasonal demand for some products, in particular dairy compounds, and in part due to the wide range of products that such plants produce. In other countries the supply of raw materials may also produce a seasonal pattern of activity. Where plants are likely to have to produce a large number of different compounds, it would be advisable to make costings which assume that the plant operates at about 75 per cent capacity. However, if the production schedules are simple and are a reliable basis for calculation, as when the mill is integrated with its market, a higher rate of utilisation should be assumed.

SHIFT WORKING

Though the equipment is designed to operate continuously, it is assumed that only one eight hour shift per day is worked, for 300 days per year, since shift working is uncommon in many developing countries. The models can be easily adapted however, to show the effect of continuous operation.

Two or three shift working is common in developed countries. Since all but about 5 per cent of operating costs vary directly with output, the reduction in average unit costs would not be large in most circumstances. Savings would consist of management, electricity and depreciation charges, and would tend to be offset by higher depreciation charges arising from increased storage requirements, and by the possible necessity for paying higher wage rates to shift workers.

THE PRODUCTS

Model I

This plant is capable of making compounds for poultry, pigs and cattle. However, a single commercial pig or poultry enterprise of only medium scale would absorb the entire output of the plant (2,400 tons per annum). Thus it is probably more realistic to assume that a plant at this scale will produce compounds for cattle.

2,400 tons is sufficient to supply a dairy supplement for between 1,000 and 2,000 cattle or buffalo, depending on the level of feeding.

The formulation of the products depends largely on the availability of raw material supplies. For the purpose of estimating requirements it was assumed that crops would be available only from the previous harvest. The prices used in the tables are therefore the average post-harvest prices for the materials used in possible formulations appropriate to the southern Asian country to which the models apply, and which are shown in appendix 3, tables 6 and 7. The simple formulations shown provide a protein rich supplement, balanced with energy-giving material and minerals. Molasses is included both as a readily available source of energy and because it increases the efficiency of pelleting. These compounds could be fed as a meal or as pellets. However, because of the wide demand for them, the model is designed to produce the whole of its output as pellets. A mineral supplement is included because of the widespread mineral deficiencies in the feeds of less developed countries. Where the raw materials fed to cattle come from one fairly small area it is probable that there will be important deficiencies, so it is advisable for a specialist to determine the best method of supplementation.

The nutritional requirements of dairy cattle vary according to the season of the year. During and just after a wet season, the forage which constitutes the basic diet of most cattle, contains more protein and less material for providing energy than during the dry season. In the area of South Asia for which all the models are costed, the wet season usually lasts from April to July, and the forage remains in good condition until the end of August. The dry season then lasts, in effect, for the rest of the year. The dairy compound fed to cattle in this area should, therefore, contain less protein and more fibre (16 and 10 per cent respectively) in the wet season than in the dry season (19 and 7 per cent respectively).

Six very simple formulations that could be made in various parts of the world into a dairy supplement of the type described above in the plant embodied in Model I are shown in table 5.2 (page 28). These formulations are purely illustrative, they are introduced to give an idea of the kinds of raw materials and the proportions that can be used to make this product.⁽²⁾ Specific recommendations for formulations in any area should be based on an up-to-date analysis of the actual raw materials to be used. Although the materials mentioned are widely known, many less well known materials can be used.⁽³⁾ It must be remembered that these compounds are extremely simple, more raw materials can be included in a compound feed for dairy supplements and that these compounds could be made in this plant. However, the number that can be included without reducing the throughput is limited by the simple manual blending technique employed. The actual maximum number would depend on the efficiency of the management and supervision.

(2) The nutritional requirements of cattle are set out in Chapter 2.

(3) A more extended range of raw materials is discussed in Chapter 3. Care should be taken in making substitutions between raw materials, even if their nutritional constitution appears the same. Formulation is a subject for experts.

Table 5 : 2 Formulations of a dairy supplement using raw materials from different geographical areas

Raw materials ⁽¹⁾ Percentage included in compound		Raw materials Percentage included in compound		Raw materials Percentage included in compound	
I		III		V	
Wheat or rice bran	26	Citrus pulp	27	Maize, wheat, barley or rice	64
Coconut cake	64	Coconut cake	63	Groundnut cake	26
Molasses	8	Molasses	8	Molasses	8
Mineral supplement	2	Mineral supplement	2	Mineral supplement	2
Total	100	Total	100	Total	100
II		IV		VI	
Wheat or rice bran	55	Cassava, plantain yam or sweet potato chips	27	Maize, wheat, sorghum or millet	50
Soya bean or groundnut cake	35	Palm kernel or coconut cake	63	Coconut or palm kernel cake	40
Molasses	8	Molasses	8	Molasses	8
Mineral supplement	2	Mineral supplement	2	Mineral supplement	2
Total	100	Total	100	Total	100

Footnote: (1) for Latin names and nutritional specifications see Appendix 1.

Model II

As with Model I, this is a standardised plant which can produce the full range of compound animal feeds, for poultry, pigs and cattle. In this case also the output of the mill would be small relative to the demand of a single pig or poultry enterprise, so the model is costed on the assumption that it produces a dairy cattle supplement only. Therefore, the assumptions made about the operation of the plant are the same as those for model I. The costs of raw materials for Model II can be obtained by multiplying those for Model I (in appendix 3, table 6) by a factor of 2.5 to bring the quantities up to scale.

Model III

This process is identical to that of Model II. The grinder, pelleter and motor together with the elevators have a larger capacity than the Model II, but the mixing section consists of the same machines. The plants in these two made by the same manufacturer, and the similarity results from standardisation of the manufacturers products. However, this model is assumed to produce products to be fed to poultry, though the plant costed in the model is capable of producing feeds for cattle and pigs as well. In a commercial enterprise poultry will usually be given a complete feed, i.e. one which is their only source of nutriment. Three basic products are required: a starter feed, a grower or finisher feed, and a breeder feed. A breeder feed has a very similar composition to a feed for layers, and the same product can be sold under a different label. The actual amounts of each produced will depend on the particular circumstances of the mill. In appendix 3, table 7, the formulations used in this model and their costs are shown, based on the same assumptions as those for the previous models. These formulations are designed to meet the nutritional requirements of the various classes of poultry, as set out in chapter 3, using only very simple combinations of raw materials. Actual formulations for use in a feasibility study should be prepared by experts

using detailed information on the supply of raw materials.

The number of formulations made in the same period in this model will probably mean that the plant will have to be stopped during shifts to change the grinder screens and the pelleter dies, or to adjust these machines.

In this plant the output is limited by the capacity of the grinder. When the formulation changes, either because a new set of raw materials is to be used or because the product to be produced changes, the blending section stops to allow the grinding section to empty. Thus although the formulations used in the costing are simple the plant is likely to be halted during each shift either to change the formulation or the product, either stop involving about $\frac{1}{2}$ hour in all. This is the time required for slowing, cleaning and changing the settings, including the screen in the grinder and the die of the pelleter. These stoppages reduce the annual throughput. In this model it is assumed that two stoppages of $\frac{1}{2}$ hour each occur in each shift. As the number of formulations and products made in any mill increase this period will increase and can become very important.

Model IV

This plant is able to produce feeds for all types of animal, and can utilise up to six main ingredients, so that complicated formulations may be used without incurring delays and lower throughput. The model is costed using the same assumptions as for Model III. Namely, three poultry products are made whose formulation changes with the raw material supply. The costs of raw materials in Model IV are obtained by multiplying those in Model III by a factor of 1.6.

The economics of small-scale production

OBJECTIVES

In order for the objective of successful and profitable production of compound animal feeds to be carried out, certain requirements must be fulfilled, and these are often in conflict with each other. They are:

1. The product must be made for as low a cost as possible
2. The products must be marketable
3. The products must have as high a conversion ratio into animal product as possible.

The costs of producing compound animal feeds are largely determined by the raw material costs and the processing and sales costs. The raw material costs of feeds are reduced by calculating least cost formulations and by reducing losses during processing. Material losses occur during processing in the form of moisture or dust. Moisture losses can be made good by adding water to the meals or by the application of steam during pelleting. Dust losses are minimised by using the mill sweepings in some compounds, and by using efficient aspiration equipment to control dust during processing. Processing costs can also be reduced by having plant and machinery designed for the raw materials and product mix of the mill, and by using this machinery efficiently.

Least cost formulations should be checked to ensure that they have good sales qualities, possibly by test-marketing, and should be changed if these are lacking. Formulations are most conveniently obtained as part of a service provided by the suppliers of vitamin, mineral and other supplements for compound feeds, since they will be able to combine cheapness with nutritive qualities.

CAPITAL COSTS

The following table shows the percentage of total capital costs that can be attributed to various items. The figures correspond to those given in table 1, appendix 3.

Table 6 : 1 Breakdown of capital costs by percentage

	Model I	Model II	Model III	Model IV
Plant and machinery	25.2	30.2	24.3	20.6
Factory building	2.5	1.4	1.2	1.6
Warehouse	21.4	17.1	18.7	19.8
Working capital	51.0	51.4	55.8	58.0

It is assumed that machinery will be imported, and therefore involves payment of foreign exchange. It is possible that bins, ducts, pipes and other sheet metal equipment can be made locally in the more industrialised developing countries,

and grinders and mixers are made in a few of them. However, even locally made equipment will usually involve indirect import requirements.

A high proportion of total capital costs is accounted for by storage warehousing in which provision is made for three months' supply of raw materials, and four months' supply in the case of Model I. Initially these buildings may provide more space than is required, but it is recommended that the supply of raw materials is carefully studied before a smaller allowance for storage space is made. Indeed, some feed mills will find it profitable to supply long term storage facilities, buildings for which may have to be considerably more expensive than the simple warehouse costed in these models, in order to take advantage of changes in the supply situation.

Alternative methods of storage of raw materials (pits, bins etc.) can be worthwhile either when they are more technically suitable, or when raw materials arrive and are handled in bulk. The costs of such systems are large in comparison with the costs of a warehouse, but will in part be offset by the savings in labour costs. Unfortunately many bulk handling and storage systems suffer from inflexibility and when a change in the supply of raw materials occurs, require further capital expenditure.

It has been assumed that three months' operating costs are required for working capital, though this will over-estimate the allowance needed for many items. The main constituent of working capital is the cost of raw materials, consequently the factors which affect working capital requirements are similar to those which determine storage space. If the need to store raw materials, or pay in advance of delivery, is reduced, then working capital requirements will be reduced. It is common for feed mills to work out their working capital requirements at least twice yearly and consequently take advantage of, or make provision for, changes in the requirement for working capital. Since working capital accounts for such a high proportion of the capital invested it is advisable that particular attention is paid to this item in the preparation of feasibility studies.

OPERATING COSTS

Summary

The following table shows the percentage breakdown of operating costs, and corresponds to the figures in table 1, appendix 3.

Table 6 : 2 Breakdown of operating costs by percentage contributions

	Model I	Model II	Model III	Model IV
Raw materials	73.9	76.8	79.0	80.4
Sacks	1.7	1.7	1.6	1.6
Electricity	1.0	0.9	0.7	0.5
Spare parts	0.9	0.5	0.3	0.3
Product delivery	2.1	2.1	2.1	2.1
Management	3.4	1.7	1.0	0.7
Labour	4.8	3.6	2.8	2.1
Maintenance	1.1	1.5	1.1	0.9
Interest	2.0	2.1	2.0	2.0
Advertising	3.7	3.8	4.0	4.0
Unforeseen	4.7	4.7	4.7	4.7
Other overheads	0.8	0.8	0.7	0.7

Raw materials

The high proportion of operating costs accounted for by raw materials has been confirmed by compounders who were contacted during the preparation of this report. Since they do constitute such a high proportion, and since these costs also play a large part in determining the working capital requirements and the interest to be paid on them, the greatest care is needed when assessing these costs for the purpose of feasibility studies.

Sacks

In the cost models it is assumed that raw materials arrive, and are handled and distributed in the same reusable 112 lb sacks. Another assumption which would generate the same costs is that the sacks in which the raw materials arrive are returned to their suppliers, while the miller distributes his products in his own reusable sacks. In this case a hire charge would be made to cover the worn-out sacks, i.e. at the same cost as in the models. If the products are sold in non-reusable sacks, the firm would have to bear the extra cost of the sacks, printing etc.

Increasingly compound feeds are distributed in bulk which saves mainly on the labour required to operate a warehouse for storage of final products. The capital cost of such systems is large, suitable transport would have to be provided, and customers would have to have special material reception equipment.

Power

The power costs of compound mills are not large, but the higher degrees of automation in modern feed mills, involving mechanical handling devices, automatic blending equipment etc., may not spread very rapidly in developed countries because of the extra costs of power involved. To some extent the power costs are variable in that the amount required will vary with the actual materials to be ground and the fineness to which they are ground. Power costs can also be reduced by excluding pelleting, or by reducing the time spent on each mix.

Delivery charges

Delivery charges vary considerably between feed mills, and between individual sales by a feed mill, so these costs will be important in determining the size and location of the feed mill. The actual method of charging for delivery varies between mills, some differentiate between loads, others make a uniform charge for all products. As mentioned above, bulk delivery systems entail specialised transport equipment, and matching reception equipment, so are mainly suitable for plants which are integrated with their markets.

Manpower

The proportion of costs constituted by manpower decreases significantly with increases in scale, and in more automated plant unskilled workers and supervisory staff are not necessary. No allowance has been made in the models for sales staff. The larger feed mills in developed countries maintain considerable sales forces of men who are partly paid by salary and partly on a performance basis. These people are capable of explaining the advantages of the mills' products and of arranging for special products to be made for the particular requirements of individual customers, and can be very important in keeping the mill in touch with the changing market requirements. Some mills also have a specialist staff of advisors who develop new products and deal with difficulties that the sales staff encounter. In less developed

countries staff capable of these activities is likely to be scarce and sales promotion is likely to be limited to billboard and journal advertising, and mobile demonstration and promotion units. Some feed mills may operate an experimental and demonstration farm. Costing these projects would be beyond the scope of this report and consequently all sales costs have been incorporated as an arbitrary constant proportion of raw material costs under the heading of Advertising.

Unforeseen

The large allowance that has been made under this heading is intended to cover both price and quantity variation in the operating requirements. The costs about which there will probably be most uncertainty are the raw material costs, and sales costs. The allowance can be adjusted to more realistic levels during feasibility studies.

Pelleting

The cost of pelleting mixed meals may well exceed the value of the extra sales. In plants I, II and III the capital costs of the pelleting section constitute about 60 per cent of machinery costs, 30 per cent of fixed capital requirements and about 15 per cent of total capital requirements. About 5 per cent of total annual sales cost is directly due to pelleting (20 per cent of the processing cost), over half of which is due to depreciation charges. Consequently it is desirable to obtain a high utilisation of the pelleting capacity. In plant IV, the capacity of the pelleting section is about half that of the mill as a whole, and only a portion of the total output is in the form of pellets. In this case, pelleting costs are only 30 per cent of machinery costs.

Most modern feed mills are in fact like plant IV in this respect. The proportion of pellets to total output is unlikely to rise very high because it is now thought that only in a few cases are pellets economically worthwhile to feed to animals. In developed countries growing broilers and dairy cattle are usually fed with pellets. It is thought that in the case of broilers their appetite limits their performance, consequently careful balancing of their rations, and the elimination of selectivity among the ingredients of the ration, results in the extra performance. In the case of dairy cattle, the advantages of pellets result in part from the elimination of selectivity, but mainly from the ease and cleanliness in the handling of the compounds which are usually fed in the milking parlour. Pellets also allow high fat and molasses compounds to be handled and fed without difficulty.

PRICES OF PRODUCTS

The best means of calculating the prices to be charged for the products of a feed mill would be to relate them to prices paid for products already on the market. However, this information is not available for the present study. A second method, which can be used when making feasibility studies, but which is not appropriate to the general approach used here, is to base prices on the results of market research carried out on prospective customers.

In order to give an indication of the general magnitude of prices the 'cost-plus' method of pricing has been used in table 1, appendix 3. According to this method a price is charged that will cover all the outlays of the plant, and yield an acceptable rate of profit. If the acceptable rate of profit is taken as 15 per cent the price can be calculated by first adding 15 per cent of the total capital outlay to total costs, and then dividing this amount by the annual output. This method can be used in feasibility studies to indicate viable price levels. The calculation can be made more realistic by pricing the individual compounds to be marketed. This can be done by breaking down the costs of production and allocating them to each product made.

In practise it is difficult to make this breakdown except in the case of raw material costs. This method is shown in tables 6 and 7, appendix 3.

Another method that can be used to estimate prices in the absence of any direct comparative data is to examine the existing production and marketing of animal products, to estimate what gain would accrue as a result of the manufacture of feedingstuffs, and to take this gain as an indication of the prices that can be charged.

In cases where there are a large number of raw materials available, and where there is a demand for a number of different products it may be useful to use linear programming techniques to estimate the best output mix and pricing policy. In such cases professional advice would be required.

It should be noted that in the calculations in table 1, appendix 3, no allowance has been made for tax, since this would complicate the calculation without giving much useful information that could be adapted to individual cases. Where feasibility studies are carried out it is necessary to add taxes, and to deduct subsidies from the total outlay in the calculation of prices and returns.

Appendix 1

Table 1
Composition of cereals and their by-products

Material		Dry matter per cent	Crude protein (N x 6.25) per cent	Oil (ether extract) per cent	Crude fibre per cent	Nitrogen free extract per cent	Mineral matter (ash) per cent
Common name	Latin name						
Barley.....	<i>Hordeum</i> spp	85.0	9.0	1.5	4.5	67.4	2.6
Barley feed.....	"	89.0	13.0	3.4	8.5	59.9	4.2
Barley, Brewers' grains, dried.....	"	89.7	18.3	6.4	15.2	45.9	3.9
Wheat.....	<i>Triticum vulgare</i>	87.0	12.2	1.9	1.9	69.3	1.7
Wheat feeds from flour milling.....	"	86.7-87.0	14.7-17.0	3.8-4.5	2.3-10.3	52.1-60.8	2.4-5.9
Maize.....	<i>Zea mays</i>	87.0	9.9	4.4	2.2	69.2	1.3
Maize germ meal.....	"	89.0	13.0	12.5	4.1	55.8	3.6
Flaked maize.....	"	89.0	9.8	4.3	1.5	72.5	0.9
Maize gluten feed.....	"	90.3	24.8	2.5	7.2	48.1	7.7
Oats.....	<i>Avena sativa</i>	87.0	10.4	4.8	10.3	58.4	3.1
Brown rice.....	<i>Oryza sativa</i>	86.6	8.3	1.8	8.8	64.7	5.0
Polished rice.....	"	87.0	6.7	0.4	1.5	77.6	0.8
Rice bran.....	"	90.8	12.4	13.6	11.6	39.9	13.3
Rice meal.....	"	91.1	12.9	13.7	6.4	49.5	8.6
Sorghum (American).....	<i>Sorghum</i> spp	89.6	10.8	2.8	2.3	71.7	2.0
Sorghum (guineacorn).....	"	88.0	10.4	3.4	2.0	71.0	-
Millet American foxtail varieties.....	<i>Setaria italica</i>	89.1	12.1	4.1	8.6	60.7	3.6
Millet, bullrush type.....	<i>Pennisetum americanum</i>	88.0	11.0	5.0	2.0	69.0	-
Millet, finger.....	<i>Eleusine coracana</i>	88.0	6.0	1.5	3.0	75.0	-
Teff.....	<i>Eragrostis tef</i>	89.0	8.5	2.2	2.2	73.0	-
Buckwheat.....	<i>Fagopyrum esculentum</i>	88.0	10.3	2.3	10.7	62.8	1.9
Findi.....	<i>Digitaria exilis</i>	90.0	7.7	1.8	6.8	71.0	-
Job's tears.....	<i>Coix lachrymajobi</i>	88.0	14.0	4.0	0.7	68.0	-
Rye.....	<i>Secale cereale</i>	87.0	11.6	1.7	1.9	69.8	2.0

Source: see bibliography

Table 2
Composition of pulses usable as animal feed materials

Material		Dry matter per cent	Crude protein (N x 6.25) per cent	Oil (fat) per cent	Crude fibre per cent	Nitrogen free extract per cent	Mineral matter (ash) per cent
Common name	Latin name						
Pigeon pea.....	<i>Cajanus cajan</i>	89	20.9	1.7	8.0	54.9	3.5
Chick pea (Bengal gram).....	<i>Cicer arietinum</i>	89	20.1	4.5	4.9	56.6	2.9
Horse gram.....	<i>Dolichos uniflorus</i>	90	22.0	0.6	5.3	61.0	0.9
Hyacinth bean.....	<i>Lablab niger</i>	89	22.8	1.0	4.6	57.5	3.1
Lathyrus pea (Khesari dhal).....	<i>Lathyrus sativus</i>	90	25.0	1.0	15.0	46.0	3.0
Lentil (split pea).....	<i>Lens esculenta</i>	89	24.2	1.8	3.1	57.7	2.2
Lupine (South American).....	<i>Lupinus</i> spp	92	44.3	16.5	7.1	21.1	3.3
Yellow lupins.....	"	87	41.8	5.5	10.4	24.8	4.5
Lima (butter) bean.....	<i>Phaseolus lunatus</i>	89	19.7	1.1	4.4	60.4	3.4
Green and black (respectively) mung beans.....	<i>Phaseolus aureus</i> and <i>mungo</i>	89	23.9	1.3	4.2	56.2	3.4
Kidney beans.....	<i>Phaseolus vulgaris</i>	89	22.1	1.7	4.2	57.2	3.8
Peas.....	<i>Pisum sativum</i>	89	22.5	1.8	5.5	57.6	2.6
Velvet bean.....	<i>Stizolobium deeringianum</i>	90	24.0	5.0	5.0	53.0	3.5
Broad bean.....	<i>Vicia faba</i>	89	23.4	2.0	7.8	52.4	3.4
Cowpea.....	<i>Vigna unguiculata</i>	89	23.4	1.8	4.3	56.0	3.5
Bambara groundnut.....	<i>Voandzeia subterranea</i>	89	17.7	6.3	4.9	56.8	3.3

Source: see bibliography

Table 3
Composition of oilseed residues used as animal feed materials

Material		Dry matter per cent	Crude protein (N x 6.25) per cent	Oil (ether extract) per cent	Crude fibre per cent	Nitrogen free extract per cent	Mineral matter (ash) per cent
Common name	Latin name						
Castor bean meal (detoxicated).....	<i>Ricinus communis</i>	90	29.2	1.4	37.1	15.9	6.4
Coconut cake.....	<i>Cocos nucifera</i>	90	21.2	7.3	11.4	44.2	5.9
Cotton seed cake (decorticated).....	<i>Gossypium hirsutum</i>	90	41.1	8.0	7.8	26.4	6.7
Cotton seed cake (undecorticated).....	"	92.4	28.0	5.2	21.4	33.2	4.6
Groundnut cake (decorticated).....	<i>Arachis hypogaea</i>	90	45.4	6.0	6.5	26.4	5.7
Groundnut cake (undecorticated).....	"	90	30.3	9.1	23.0	21.9	5.7
Groundnut extract meal (decorticated).....	"	90	49.7	0.7	7.9	26.0	5.7
Kapok seed cake.....	<i>Ceiba pentandra</i>	86	26.9	7.0	25.7	20.1	6.3
Linseed cake.....	<i>Linum usitatissimum</i>	90	31.9	6.9	9.4	36.2	5.6
Mustard seed, extracted meal.....	<i>Brassica</i> spp	88	22.8	2.0	16.0	40.6	6.6
Mustard seed cake.....	"	88	18.0	7.5	17.5	40.0	5.0
Niger seed cake.....	<i>Guizotia abyssinica</i>	89	32.4	5.8	18.1	23.4	9.3
Palm kernel cake.....	<i>Elaeis guineensis</i>	89	19.2	6.0	13.4	46.5	3.9
Palm kernel, extracted meal.....	"	90	20.4	0.9	15.0	49.7	4.0
Rape seed, extracted meal.....	<i>Brassica rapa</i>	89	36.8	3.1	9.3	32.5	7.3
Rape seed cake.....	"	91	35.3	9.6	8.3	25.5	12.3
Sesame seed cake.....	<i>Sesamum indicum</i>	91	44.7	11.9	4.5	21.0	8.9
Sesame seed extracted meal.....	"	94	46.4	2.4	7.7	26.7	10.8
Shea nut cake.....	<i>Butyrospermum parkii</i>	90	12.1	6.5	4.8	60.7	5.9
Soya bean cake.....	<i>Glycine max</i>	89	44.9	5.8	5.3	27.4	5.6
Soya bean extracted meal.....	"	89	44.8	1.5	5.1	32.1	5.5
Sunflower seed cake (decorticated).....	<i>Helianthus annus</i>	90	37.2	13.7	12.1	20.3	6.7
Sunflower seed cake (undecorticated).....	"	90	18.5	7.2	29.1	28.0	7.2
Sunflower seed, extracted meal.....	"	90	38.1	1.0	16.3	28.1	6.5

Source: see bibliography

Table 4
Composition of dried starchy roots and tubers

Material		Dry matter per cent	Crude protein (N x 6.25) per cent	Oil (fat) per cent	Crude fibre per cent	Nitrogen free extract per cent	Mineral matter (ash) per cent
Common name	Latin name						
Cassava roots, dried.....	<i>Manihot esculenta</i>	94.4	2.8	0.5	5.0	84.0	2.0
Cassava flour.....	"	88.1	1.6	0.6	2.4	82.2	1.3
Potato meal or dried potatoes.....	<i>Solanum tuberosum</i>	91.4	9.7	0.3	2.1	75.0	4.3
Sweet potato meal or dried sweet potatoes.....	<i>Ipomoea batatas</i>	90.2	4.9	0.9	3.3	77.0	4.1
Yam peeled and dried..	<i>Dioscorea</i> spp	90.0	7.1	0.7	3.1	75.7	3.4

Source: see bibliography

Table 5
Composition of animal products used as feed materials

Material	Dry matter per cent	Crude protein (N x 6.25) per cent	Oil (ether extract) per cent	Crude fibre per cent	Nitrogen free extract per cent	Mineral matter (ash) per cent
Blood meal.....	86.0	81.0	0.8	—	1.5	2.7
Pure meat meal.....	89.2	72.2	13.2	—	—	3.8
Meat and bone meal.....	90.3	50.3	15.0	—	1.0	24.0
Meat and bone meal (solvent extracted)	93.7	49.9	3.7	2.4	3.3	34.4
Bone meal (cooked).....	93.6	26.0	5.0	1.0	2.5	59.1
Bone meal (stewed).....	95.5	7.5	1.2	1.5	3.2	82.1
Whole meat meal.....	92.0	60.0	16.0	—	—	16.0
Poultry by-product meal	93.4	55.4	13.1	1.6	4.6	18.7
Hatchery waste (dried).....	93.7	45.7	30.8	—	4.8	12.4
Feather meal.....	94.6	87.4	2.9	0.6	—	3.7
Dried whole milk.....	95.8	25.5	26.5	[—]	37.4	6.4
Dried skimmed milk.....	89.7	32.8	1.5	—	47.9	7.5
Dried whey.....	92.2	12.6	1.4	—	70.5	7.7
Fish meal (white).....	87.0	61.0	3.5	—	1.5	21.0
Fish meal (menhaden)	93.5	62.1	8.3	0.7	4.2	18.2
Fish solubles (dried).....	91.2	71.3	8.5	0.6	0.8	10.0

Source: see bibliography

Table 6
Composition of miscellaneous materials used as animal feed

Material		Dry matter per cent	Crude protein (N x 6.25) per cent	Oil (fat) per cent	Crude fibre per cent	Nitrogen free extract per cent	Mineral matter (ash) per cent
Common name	Latin name						
Beet pulp dried.....	—	91.2	8.8	0.6	19.6	58.7	3.5
Beet molasses.....	—	80.5	8.4	—	—	62.0	10.1
Beet pulp molasses, dried.....	—	92.2	8.9	0.5	15.2	61.8	5.8
Cane molasses (blackstrap).....	—	73.4	3.0	—	—	61.7	8.6
Carob bean pods.....	<i>Ceratonia siliqua</i>	89.5	4.7	2.5	8.7	70.9	2.7
Carob bean seeds.....	"	88.5	16.7	2.6	7.6	58.4	3.2
African locust bean seeds.....	<i>Parkia</i> spp	90.0	26.0	10.0	3.0	47.0	—
Dried grass (leafy).....	—	90.0	15.0	2.6	20.9	40.7	10.8
Lucerne (alfalfa) meal, dehydrated.....	<i>Medicago sativa</i>	92.7	21.1	3.3	17.5	39.3	11.5
Date stones (Iraqi)	<i>Phoenix dactylifera</i>	91.1	6.0	7.2	14.7	60.1	3.1
Yeast, brewers', dried...	—	94.0	44.9	0.7	2.7	38.8	6.9
Yeast, torula, dried.....	—	92.3	46.4	1.2	2.5	34.0	8.2
Sago flour.....	<i>Metroxylon sagu</i>	86.0	0.7	0.2	0.2	84.5	0.4

Source: see bibliography

Table 7
Vitamin contents of some animal feed materials

(a) of vegetable origin

Material	Vitamin A potency IU per g	Vitamin E (α -tocopherol) mg per 100g	Choline mg per 100g	Riboflavin mg per 100g	Nicotinic acid mg per 100g	Vitamin B12 (Cyanocobalamin) milli micro g per g	Thiamine mg per 100g
Barley.....	0.7	0.50	111	0.13	5.2	3.3	0.50
Maize (yellow).....	5.0	0.40	111	0.11	2.1	0.2	0.40
Millet <i>Pennisetum spp</i>	negligible	—	—	0.05	1.0	—	0.20
Millet <i>Eleusine coracana</i>	negligible	—	—	0.07	0.8	—	0.15
Millet <i>Setaria italica</i>	negligible	—	—	0.10	1.0	—	0.60
Oats.....	0.6	0.50	93	0.11	1.6	3.3	0.50
Brown rice.....	—	1.20	78	0.04	1.5	—	0.25
Rice bran.....	—	—	99	0.26	27.5	—	1.80
Sorghum (milo).....	0.7	—	44	0.11	5.8	1.1	0.40
Wheat.....	0.4	1.60	73	0.11	18.8	—	0.80
Wheat bran.....	0.4	1.00	102	0.29	2.9	—	0.50
Bean meal.....	—	0.10	111	0.31	2.4	—	0.70
Pea meal.....	0.5	0.30	221	0.18	—	—	—
Coconut extracted meal.....	—	0.16	111	0.33	2.7	—	0.09
Cottonseed cake (decorticated).....	0.3	1.90	261	0.49	3.3	—	0.60
Groundnut cake (decorticated).....	0.3	—	188	0.22	16.6	0.1	—
Linseed cake.....	0.4	—	166	0.35	4.0	—	0.60
Palm kernel meal.....	—	—	—	—	—	—	0.30
Sesame meal.....	0.7	—	144	0.37	—	—	0.80
Soya bean meal.....	—	0.08	284	0.40	3.2	—	—
Sunflower seed cake, decorticated.....	—	0.60	120	0.40	25.0	—	—
Dried grass meal.....	327.5	15.00	89	1.55	7.4	—	—
Dried lucerne (alfalfa) meal.....	267.0	20.00	111	1.66	4.3	2.7	—
Yeast, brewers', dried...	—	—	362	4.5	48.7	1.1	9.20
Molasses.....	—	—	64	0.22	4.4	—	0.09

(b) of animal origin

Material	Vitamin A potency IU per g	Vitamin E (α -tocopherol) mg per 100g	Choline mg per 100g	Riboflavin mg per 100g	Nicotinic acid mg per 100g	Vitamin B12 (Cyanocobalamin) milli micro g per g	Thiamine mg per 100g
Blood meal.....	—	—	111	0.22	3.3	—	0.04
Meat meal.....	—	—	243	0.55	5.5	55.3	0.02
Feather meal.....	—	—	—	0.20	1.8	70.8	—
Fish meal.....	—	2.10	310	0.66	6.2	100.0	0.13
Fish solubles.....	4.0	—	266	2.21	32.1	143.8	—
Skimmed milk powder.....	0.3	0.04	108	2.10	1.2	55.3	0.35
Dried whey.....	—	—	155	2.66	1.1	22.1	0.40

Source: see bibliography

Table 8
Mineral contents of some animal feed materials

(a) of vegetable origin

Material	Calcium (as Ca) per cent	Magnesium (as Mg) per cent	Sodium (as Na) per cent	Potassium (as K) per cent	Chlorine (as Cl) per cent	Phosphorus (as P) per cent	Iron (as Fe) per cent
Barley.....	0.06	0.13	0.06	0.49	0.15	0.40	0.008
Maize (flint).....	0.02	0.10	0.01	0.29	0.04	0.28	0.002
Millet(bullrush) <i>Pennisetum americanum</i>	0.025	—	—	—	—	—	0.003
Millet (finger) <i>Eleusine coracana</i>	0.35	—	—	—	—	—	0.005
Millet <i>Setaria italica</i>	0.05	0.16	—	0.43	—	0.30	—
Brown rice.....	0.04	—	—	—	0.08	0.25	0.001
Rice bran.....	0.08	0.95	—	1.74	0.07	1.36	0.019
Sorghum (milo).....	0.03	0.13	0.01	0.35	0.08	0.28	0.004
Wheat.....	0.04	0.14	0.06	0.42	0.08	0.39	0.006
Wheat bran.....	0.13	0.59	0.06	1.23	0.04	1.29	0.017
Beans, lima <i>Phaseolus lunatus</i>	0.09	0.18	0.03	1.70	0.03	0.37	0.010
Cow peas <i>Vigna unguiculata</i> ...	0.10	0.26	0.27	1.30	0.04	0.46	0.036
Coconut oil cake.....	0.21	0.36	0.04	1.95	0.03	0.64	0.068
Cottonseed cake (decorticated).....	0.20	0.52	0.07	1.48	0.05	1.11	0.016
Groundnut cake (decorticated).....	0.16	0.24	0.42	1.15	0.03	0.54	—
Linseed cake.....	0.37	0.58	0.11	1.24	0.04	0.86	0.017
Palm kernel cake.....	—	—	—	0.42	—	0.69	0.017
Sesame meal.....	2.00	—	—	—	—	1.60	0.010
Soya bean meal.....	0.27	0.25	0.24	1.77	0.07	0.63	0.016
Sunflower seed meal.....	0.26	—	0.04	1.08	0.19	1.22	—
Dried grass meal.....	1.20	—	—	—	0.80	0.80	—
Dried lucerne (alfalfa) meal.....	1.74	—	—	—	—	0.28	0.039
Yeast, brewers', dried...	0.57	0.13	0.01	1.88	—	1.68	0.009
Molasses, cane.....	0.66	0.35	0.17	3.67	2.75	0.08	0.019
Molasses, beet.....	0.05	0.23	1.17	4.77	1.27	0.02	0.005
Beet pulp (dried).....	0.69	0.27	0.17	0.18	0.04	0.08	0.030

(b) of animal origin

Material	Calcium (as Ca) per cent	Magnesium (as Mg) per cent	Sodium (as Na) per cent	Potassium (as K) per cent	Chlorine (as Cl) per cent	Phosphorus (as P) per cent	Iron (as Fe) per cent
Blood meal.....	0.32	0.22	0.32	0.09	0.27	0.25	0.376
Meat meal (60 per cent crude protein).....	5.70	—	—	0.58	1.20	4.50	—
Meat and bone meal.....	7.50	—	—	0.67	1.40	5.80	—
Meat and bone scrap (50 per cent protein)	10.70	1.13	0.73	1.46	0.75	5.30	0.050
Fish meal (white)	6.76	—	—	—	—	3.69	—
Fish meal (sardine).....	4.41	0.10	0.18	0.33	0.41	2.57	0.030
Dried skimmed milk.....	1.28	0.12	—	1.46	—	1.04	0.005
Dried whey.....	0.86	—	—	—	—	0.72	0.021
Bone meal, extract.....	23.00	0.35	0.74	0.23	0.09	10.25	0.044
Bone meal, steamed.....	30.10	0.61	0.46	0.18	—	14.50	0.084

Source: see bibliography

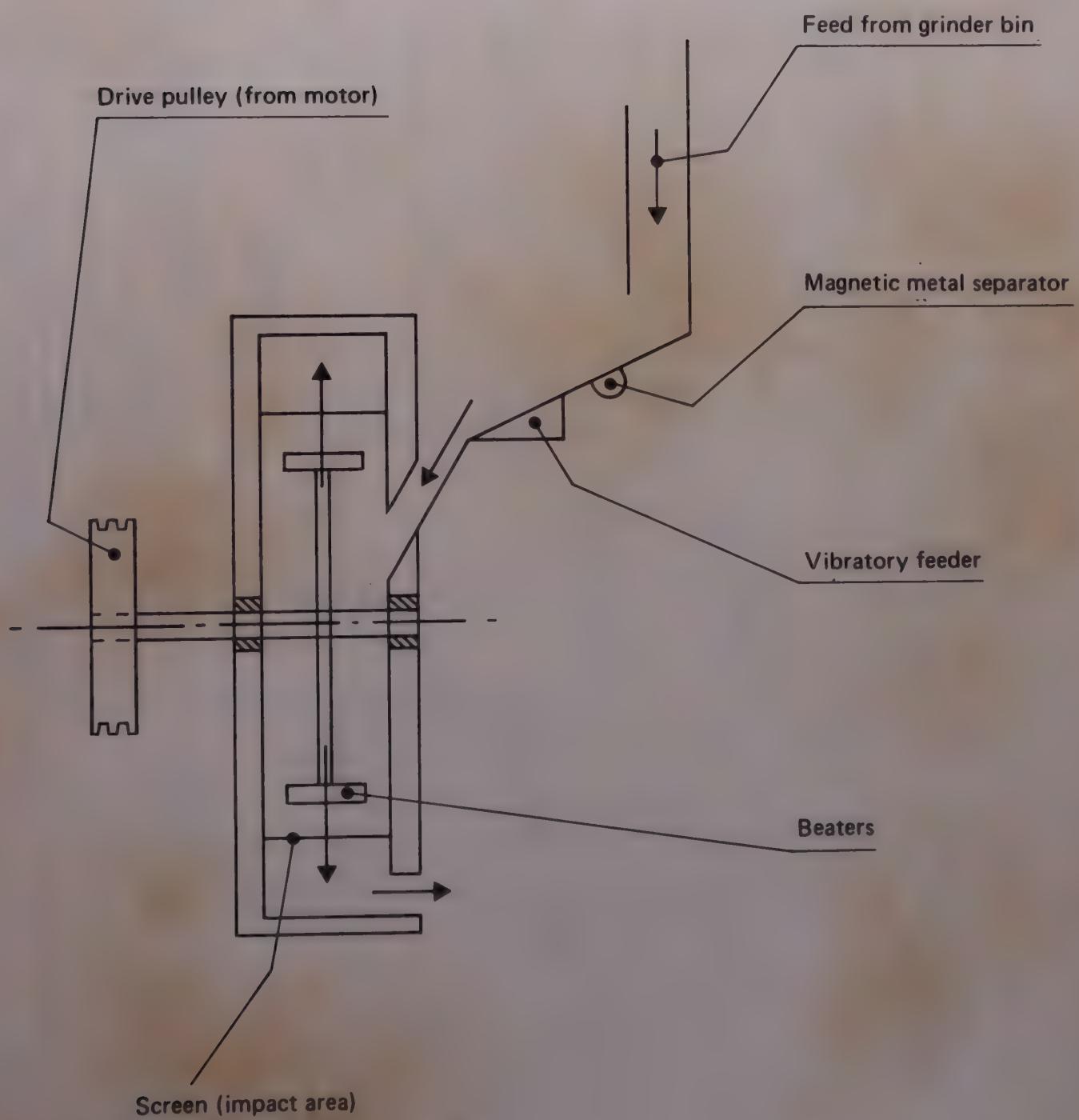
Table 9
Essential amino acid contents of some feed materials (Mg per g of total Nitrogen)

Material	Iso-leucine	Leucine	Lysine	Methio-nine	Cystine	Phenyl-alanine	Tyro-sine	Thre-nine	Tryptophan	Valine	Biologi-(1) cal value	Net protein(1) utilisation (NPU)
Barley	224	417	216	104	142	321	194	207	—	315	—	60.0
Maize	230	783	167	120	97	305	239	225	44	303	59.4	51.1
Millet, bulrush <i>Pennisetum</i> spp.....	256	598	214	154	148	301	203	241	122	345	—	—
Foxtail millet <i>Setaria italica</i>	475	1,044	138	175	—	419	—	194	61	431	—	—
Ragi millet <i>Eleusine coracana</i>	275	594	181	194	163	325	225	263	—	413	—	—
Oats.....	237	453	239	113	167	309	209	210	—	321	64.9	65.7
Rice (brown).....	238	514	237	145	67	322	218	244	—	344	72.7	70.2
Sorghum.....	245	832	126	87	94	306	167	189	—	313	73.2	55.8
Wheat.....	204	417	174	94	159	282	187	183	—	276	64.7	90.9
Lima bean <i>Phaseolus lunatus</i>	310	509	465	78	63	379	202	261	63	322	54.8	47.8
Cowpeas <i>Vigna</i> spp.....	239	440	427	73	68	323	163	225	—	283	56.8	45.1
Coconut (dried kernel).....	244	419	220	120	76	283	167	212	—	339	69.0	55.0
Cottonseed cake.....	196	363	259	89	93	320	184	205	—	271	67.2	52.7
Groundnuts (kernels).....	211	400	221	72	78	311	244	163	65	261	54.5	42.7
Linseed.....	271	382	237	122	120	299	170	239	—	339	70.8	55.6
Palm kernels.....	240	421	246	164	123	256	182	222	63	377	—	—
Sesame seed.....	226	419	171	176	113	277	195	223	—	288	62.0	53.4
Soya bean cake.....	302	489	380	89	104	313	237	267	—	327	72.8	61.4
Sunflower seed cake.....	267	399	231	154	110	304	162	228	—	322	69.6	68.3
Dried grass meal.....	583	837	447	131	80	550	194	792	55	661	—	—
Lucerne (alfalfa) meal.....	267	496	263	84	108	255	112	315	95	306	57.5	—
Yeast, brewers'.....	365	500	565	100	130	303	259	346	—	459	65.6	55.6
Blood meal.....	70	782	568	93	63	467	227	227	319	539	—	—
Meat meal.....	179	374	328	89	49	213	140	193	55	278	24	—
Fish meal.....	269	452	484	171	77	241	193	265	60	318	81.1	65.3
Dried skimmed milk.....	442	568	442	134	41	308	134	258	63	268	79.7	72.1
Poultry by- products meal.....	283	510	266	130	275	287	189	264	66	430	—	—
Feather meal.....	327	560	107	19	317	313	154	313	8	540	—	—
Whale meal	285	450	231	313	77	216	207	71	87	294	81.1	65.3

Source: see bibliography

Appendix 2

Fig. 1. Impact Grinder



NOTE: Arrows indicate flow of material.

Fig. 2. Compound Animal Feed Mill – Model I.

FLOW CHART



FLOW DIAGRAM

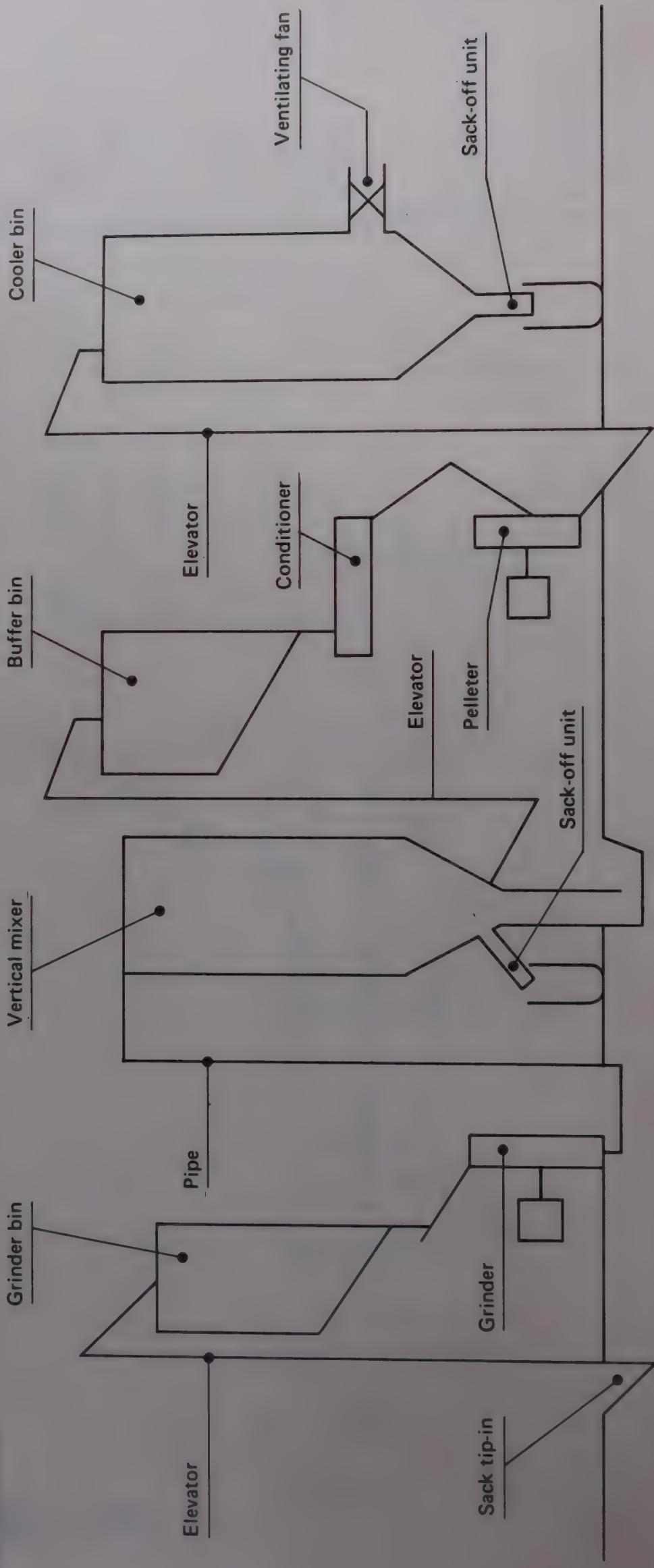
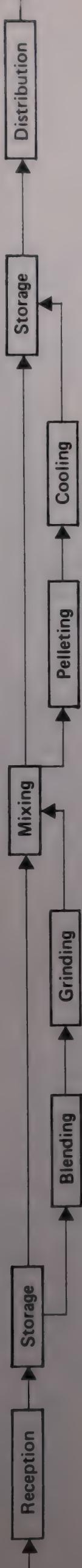


Fig. 3. Compound Animal Feed Mill – Models II & III.

FLOW CHART



FLOW DIAGRAM

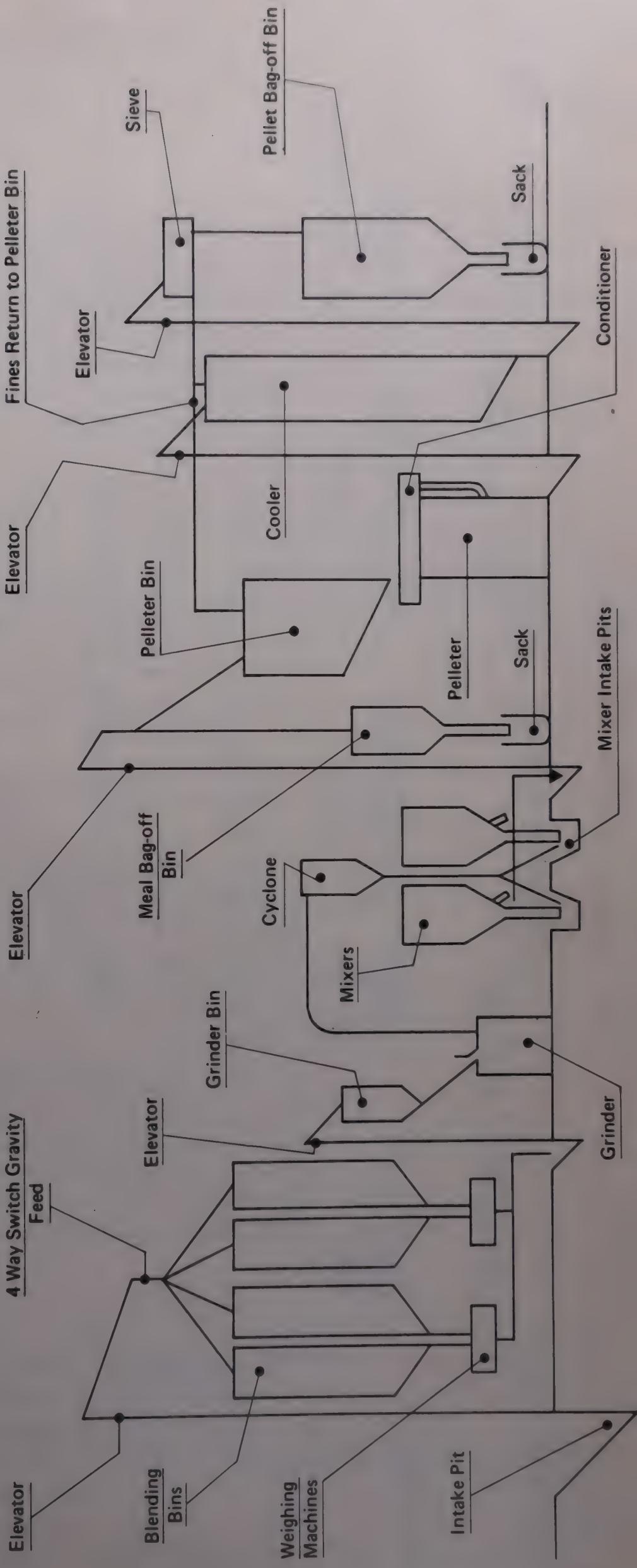
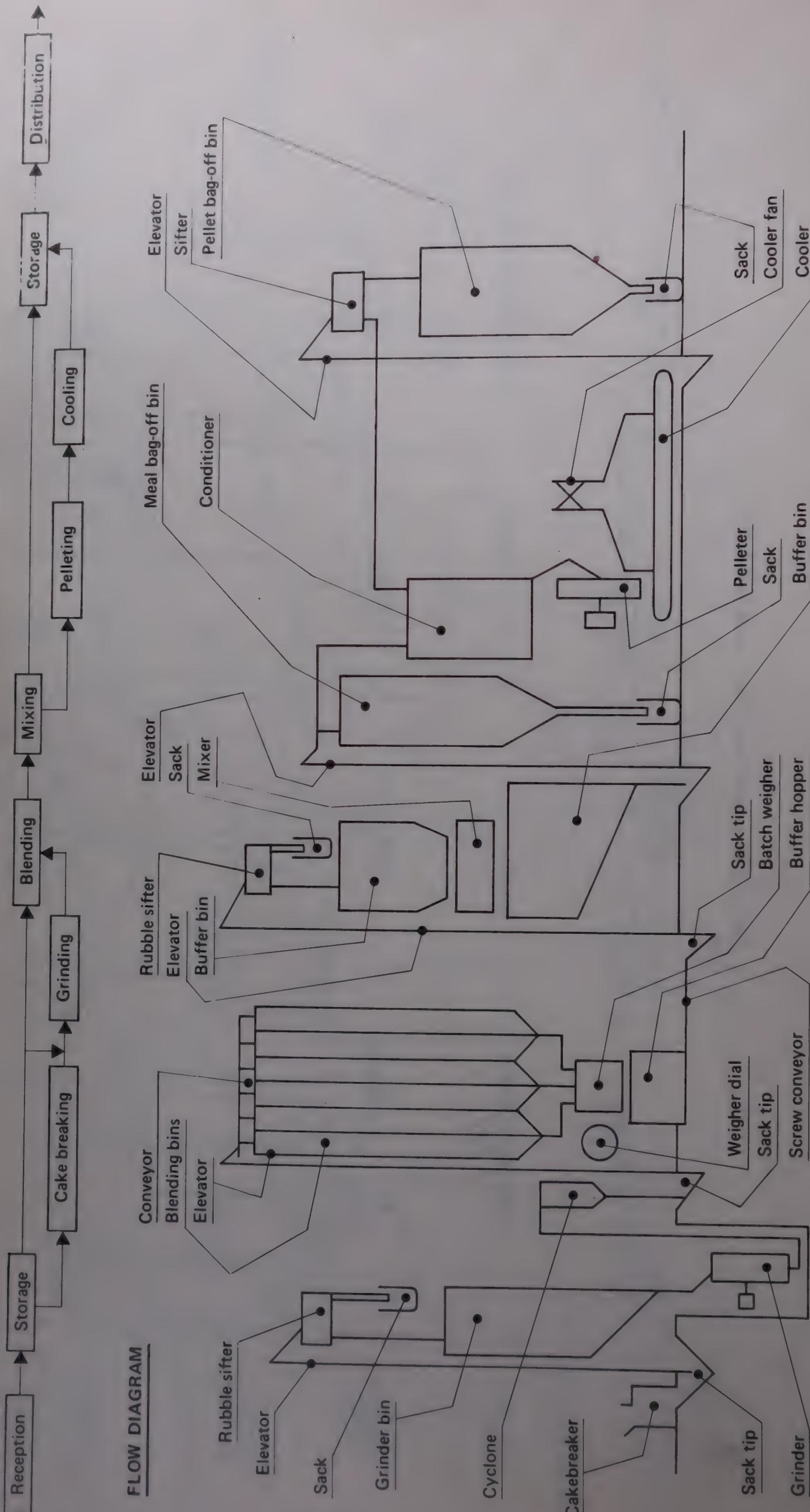


Fig. 4. Compound Animal Feed Mill – Model IV.

FLOW CHART



Appendix 3

Table 1
Capital and annual operating costs (1)

£ Sterling 1970

	Model I 2,400 tons per year dairy compound	Model II 6,000 tons per year dairy compound	Model III 10,500 tons per year poultry products	Model IV 16,800 tons per year poultry products
Capital costs				
1 Factory building.....	1,035	1,464	1,960	4,065
2 Warehouse.....	9,000	18,000	31,500	50,400
3 Machinery and equipment.....	6,745	26,359	33,447	40,728
4 Spare parts.....	1,600	2,000	2,650	4,200
5 Installation cost.....	475	950	1,300	2,500
6 Contingencies.....	943	2,439	3,543	5,095
7 Total fixed capital.....	<u>19,798</u>	<u>51,212</u>	<u>74,400</u>	<u>106,988</u>
8 Working capital.....	21,433	51,604	93,806	147,530
9 Total capital invested.....	41,231	102,816	168,206	254,518
Annual operating costs				
10 Raw materials.....	64,722	161,805	302,549	484,078
11 Sacks.....	1,400	3,500	6,125	9,800
12 Electricity (a) demand charge.....	315	1,145	1,472	1,730
(b) current charge.....	594	727	1,053	1,254
13 Spare parts.....	800	1,000	1,325	2,100
14 Product delivery.....	1,800	4,500	7,875	12,600
15 Manpower.....	7,200	11,050	14,900	16,600
16 Maintenance.....	925	3,123	4,181	5,435
17 Insurance and administration.....	621	1,577	2,629	4,025
18 Advertising.....	3,236	8,090	15,127	24,204
19 Rent on land.....	37	70	121	194
20 Unforeseen.....	4,082	9,829	17,868	28,101
21 Interest on working capital.....	1,715	4,128	7,504	11,802
22 Total operating costs.....	87,447	210,544	382,729	601,923
23 Sinking fund (a) buildings.....	940	1,824	3,135	5,103
(b) machinery.....	1,140	3,708	4,782	6,135
(c) total.....	<u>2,080</u>	<u>5,532</u>	<u>7,917</u>	<u>11,238</u>
24 Total outlay.....	<u>89,527</u>	<u>216,076</u>	<u>390,646</u>	<u>613,161</u>
25 Cost per ton of output.....	37.3	36.0	37.2	36.5
26 Price per ton at 15 per cent profit.	39.9	38.6	39.6	38.8

Footnotes:

(1) For methods of calculation see notes on pages 47 and 48.

-- Subtotal.

NOTES TO TABLE 1

Rows 1 – 4: See tables 2 through 5

Row 5: Based on inputs of skilled labour required

Row 6: 5 per cent of rows 1 through 5

Row 7: Sum of rows 1 through 6

Row 8: Calculated as one quarter annual operating costs, rows 10 through 20

Row 9: Row 7 plus row 8

Row 10: See tables 6 and 7

Row 11: Raw materials and final products are handled in sacks containing

112 lb, costing £0.175 each. One sixth of the annual requirement is replaced each year.

Row 12: See table 8
Row 13: Annual requirement calculated as one half row 4
Row 14: It has been assumed that a delivery charge of £0.75 per ton is made for all products.
Row 15: See table 9
Row 16: Calculated as 2.5 per cent of rows 1 and 2 plus 10 per cent of row 3
Row 17: Insurance is 1.5 per cent of row 7. The rest is based on 0.5 per cent of row 10
Row 18: 5 per cent of row 10
Row 19: Rent charged as £120 per acre on an area twice those shown in tables 2 through 5
Row 20: 5 per cent of the sum of rows 10 through 19
Row 21: 8 per cent of row 8
Row 22: Sum of rows 10 through 21
Row 23: Sinking fund contribution. This sum covers the depreciation and interest payments on the cost of buildings and plant. It consists of the series of constant annual sums which completely amortise the buildings in 25 years and plant and machinery in 15 years, when interest is paid on the unrepaid capital at 8 per cent per year. This rate of interest is considered to be approximately equal to the real rate of return on risk-free equity capital in the particular Asian country for which the costings were made.

Sinking fund buildings:

The sinking fund is calculated from the formula:

$$S(b) = \frac{P(b)r(1+r)^N}{(1+r)^N - 1}$$

Where $S(b)$ = Sinking fund contribution for buildings

$S(m)$ = " " " " machinery

Where P = Initial capital cost of buildings or machinery

r = Rate of interest (8 per cent per year)

N = Number of years to zero terminal value. 25 years for buildings, 15 years for machinery

$$\text{Thus } S(b) = \frac{P(b) \times 0.08 \times (1.08)^{25}}{(1.08)^{25} - 1}$$

$$= P(b) \times 0.0937$$

Sinking fund machinery:

$$\text{Also from above: } S(m) = P(m) \times 0.08 \times (1.08)^{15}$$

$$= \frac{(1.08)^{15} - 1}{(1.08)^{15} - 1} = P(m) \times 0.1168$$

Row 24: Row 22 plus row 23c
Row 25: Row 24 divided by annual output
Row 26: Row 24 plus 15 per cent of row 9 divided by annual output. Note that in this costing no allowance has been made for taxation. It will normally be necessary to use a greater mark-up than 15 per cent in order to allow for the incidence of tax.

Table 2
Model I : Capital, power and floorspace requirements⁽¹⁾

Row	Item	Description of item	Number of units	Price per unit fob UK port £ Sterling 1970	Price per unit delivered at factory £ Sterling 1970	Power requirement hp ⁽²⁾	Floorspace sq. ft	Height ft
	a	b	c	d	e	f	g	h
1	Grinding.....	Hammer mill with feed bin..... Elevator..... Cyclone and piping.....	1) 1) 1)	1,900 2,100 —)	34.33) 1.0) —)	30 15		
2	Blending.....	Batch weigher 200 lb..... Sack weigher 200 lb.....	1 1)	85 132	95 150	— —	30 30	7 7
3	Mixing and pelleting.....	Vertical base loading mixer..... Ring die pelleteer..... Elevator..... Cooling bin.....	1) 1) 1) 1)	3,400 16.0) 3,750 2.0)	6.75) 1.5) 500 16			
4	Steam.....	Boiler, 100 lb steam per hour at 50 lb psi	1	550	650	6.0	100	7
5	Spares.....	Screens 1/16 in, 1/4 in, 3/16 in and beaters..... Dies 3/8 in and 1/2 in and rollers.....	2 2)	350 400	375 425	— —	— —	— —
6	Total machinery etc		—	7,567	8,345	67.58	690	—
7	Storage of raw materials.....	Warehouse, 800 tons capacity.....	1	—	7,200 ⁽⁴⁾	—	4,800 ⁽³⁾	12
8	Storage of final products.....	Warehouse 200 tons.....	1	—	1,800 ⁽⁴⁾	—	1,200 ⁽³⁾	12
9	Production.....	Factory building.....	1	—	1,035 ⁽⁴⁾	—	690	20

Footnotes:

(1) Details of the machinery and buildings used in the model are contained in Chapter 5
 (2) All motors are suitable for operation in tropical countries
 (3) 6 sq.ft per ton. Raw material storage is equal to 4 months supply in this Model because of the minimum economic size of deliveries
 (4) £1.50 per sq.ft of building
 — nil, negligible or not available

Table 3
Model II: Capital, power and floorspace requirements⁽¹⁾

Row	Item	Description of equipment ⁽²⁾	Number of units	Price fob UK £ Sterling 1970	Price delivered at factory £ Sterling 1970	Power requirement hp	Floor-space sq.ft	Height ft
	a	b	c	d	e	f	g	h
1	Blending.....	Elevator 15 tons per hr..... 4 blending bins, total capacity 90 tons) 2 batchweighers 0.5 tons each.....)	1	3,745	4,109	2	384	43
2	Grinding and mixing.	Elevator 15 tons per hr..... Buffer bin for grinder..... 1 grinder with cyclone, feeder, piping) 2 x 1 ton vertical mixers with low level feed.....)	1	5,647	6,330	2 — 55	136	18
3	Pelleting.....	All supporting structure..... Buffer bin for pelleteer..... Pelleteer with integral conditioner..... Elevator 10 tons per hr..... Cooler with fan blower..... Elevator 10 tons per hr..... Sifter..... Pellet bag-off bin..... Molasses tank and piping.....	1	12,224	14,942	12 — 75 1 12.5 1 0.75	192	32
4	Steam.....	Boiler - 250 lb steam per hr 50 psi.....	1	900	978	10	20	12
5	Spares.....	Screens 1/16in, 1/4in, 3/16in each and beaters..... Dies 3/8in and 1/2in diameter and rollers..)	2	400 530	430 570	— —	— —	— —
6	Total.....	Machinery etc, sum rows 1 - 5.....	—	24,376	28,359	172.25	732	—
7	Storage of raw materials.....	Warehouse 1,500 tons.....	1	—	13,500	—	9,000 ⁽³⁾	12
8	Storage of final products.....	Warehouse 500 tons.....	1	—	4,500 ⁽⁴⁾	—	3,000 ⁽³⁾	12
9	Production.....	Factory building.....	1	—	1,464 ⁽⁵⁾	—	732	50

Footnotes:

(1) Details of the machinery and buildings are contained in Chapter 5
 (2) All motors are suitable for use in tropical countries
 (3) 6 sq.ft per ton
 (4) £1.50 per sq.ft
 (5) £2.00 per sq.ft in tables 3 and 4; £2.50 in table 5.
 — nil, negligible or not applicable

Table 4

Model III : Capital, power and floorspace requirements (1)

Row	Function	Description of equipment (2)	Number of units	Price fob UK £ Sterling 1970	Price delivered at factory £ Sterling 1970	Power requirement hp	Floor space sq.ft	Height ft
	a	b	c	d	e	f	g	h
1	Blending.....	Elevator: 30 tons per hour..... 4 Blending bins total capacity 185 tons..... 2 batch weighers 1 ton capacity each.....	1	5,035	5,571	2) 1) 1) 1) 2) 1)	500	52
2	Grinding and mixing.....	Elevator : 30 tons per hour..... Buffer bin for grinder..... 1 Grinder, with fan, cyclones, feeder, metal trap..... 2 x 1 ton vertical mixers with low level feed..... Elevator : 12 tons per hour..... Meal bag-off bin..... All supporting structure..... Screw conveyor 15 tons per hour..... Buffer bin for pelleter.....	1	7,977	8,848	75) 12) 1) 1) 1) 1) 100) 2)	200	23
3	Pelleting.....	Pelleter with integral conditioner..... Elevator : 15 tons per hour..... Cooler..... Elevator : 15 tons per hour..... Pellet sifter..... Pellet bag-off bin..... Molasses tank and piping.....	1	17,089	18,003	15) 2) 1) 1) 1)	260	38
4	Steam.....	Boiler 250 lb steam per hour, 50 psi.....	1	900	1,025	10	20	12
5	Spares.....	Screens 3/16in, 1/8in, 3/8in..... Beaters..... Pelleter Dies 3/16in, 3/8in, 1/2in dia..... Rollers.....	2	1,250	1,325	—	—	—
6	Total.....	Machinery etc, sum rows 1 – 5	—	33,501	36,097	223	980	—
7	Storage of raw materials.....	Warehouse 2,625 tons capacity.....	1	—	23,625 ⁽⁴⁾	—	15,750 ⁽³⁾	12
8	Storage of final products.....	Warehouse 875 tons.....	1	—	7,875 ⁽⁴⁾ 1,960 ⁽⁵⁾	—	5,250 ⁽³⁾	12
9	Production.....	Factory building.....	1	—	—	—	980	55

Footnotes:

see table 3

Table 5

Model IV : Capital, power and floorspace requirements (1)

Row	Function	Description of equipment (2)	Number of units	Price fob UK £ Sterling 1970	Price delivered at factory £ Sterling 1970	Power requirement hp	Floor space sq.ft	Height ft
	a	b	c	d	e	f	g	h
1	Grinding.....	Cake breaker with feed and discharge bins..... Elevator..... Rubble separator.....	1	6,910	7,420	10) 2) 1)	400	20
2	Blending.....	Grinder, bin, magnet, feeder, cyclone, piping, fan..... Elevator, conveyor and motorised outlets..... 6 Blending bins with level indicators, and worm bin dischargers..... Batch weigher, buffer bin, conveyor, sack tip.....	1	9,767	10,766	95) 3) 6) 1)	362	38
3	Mixing.....	Elevator, rubble separator and magnet..... Horizontal mixer, 2 buffer bins..... Sack-off bin, conveyor and elevator, water adder.....	1	5,712	6,205	3) 15) 2)	220	30
4	Pelleting.....	Elevator, magnet, buffer bin..... Conditioner and pelleter..... Molasses equipment..... Conveyor cooler..... Elevator, sifter, sack-off bin.....	1	10,656	11,138	— 85) 1) 10) 3)	594	30
5	Steam.....	750 lbs per hr boiler, 100 lbs per square inch.....	1	1,657	1,831	30	50	12
6	Electric control equipment...	Switch board, starters, wiring.....	1	3,084	3,368	—	—	—
7	Accessories and spares.....	Beaters Screens 3/16in, 1/8in, 3/8in, 1/2in dia. holes..... Dies 3/32in, 1/8in, 3/16in dia. holes..... Roller and knives.....	2	700) 1,110) 170)	2,100	—	—	—
8	Total.....	Machinery etc, sum of rows 1 - 7	—	41,746	44,928	267	1,626	—
9	Storage of raw materials.....	Warehouse 4,200 tons.....	1	—	37,800 ⁽⁴⁾	—	25,200 ⁽³⁾	12
10	Storage of final products.....	Warehouse 1,400 tons.....	1	—	12,600 ⁽⁴⁾ 4,065 ⁽⁵⁾	—	8,400 ⁽³⁾	12
11	Production.....	Factory building.....	1	—	—	—	1,626	40

Footnotes:

see table 3

Table 6

Quantities and costs of raw materials used in Model I. 2,400 tons per annum dairy pellets

Row	Formula No	Annual production tons	Raw materials ⁽¹⁾	Percentage included in compound	Total raw materials in compound tons	Price of raw material £ Sterling 1970	Total cost of raw materials £ Sterling 1970	Total cost of formula £ Sterling 1970	Cost ⁽²⁾ £ Sterling 1970 £ per ton
		a	b	c	d	e	f	g	h/b
1	I	700	Rice.....	55	385	22.68	8,730	16,700	23.86
2			Millet.....						
3			Sorghum.....						
4			Undecorticated cotton-seed cake.....						
5			Molasses.....						
6			Minerals.....						
7									
8	II	700	Rice, sorghum, millet	63	441	22.68	10,000	21,300	30.43
9			Sesame, decorticated cottonseed cake.....						
10			Groundnut.....						
11			Molasses.....						
12			Minerals.....						
13									
14	III	200	Wheat, barley.....	65	130	27.18	3,530	5,720	28.60
15			Linseed, rapeseed cake.....						
16			Molasses.....						
17			Minerals.....						
18	IV	200	Wheat, barley.....	56	112	27.18	3,040	5,470	27.36
19			Mustard seed.....						
20			Molasses.....						
21			Minerals.....						
22	V	300	Wheat, barley.....	48	144	27.18	3,910	7,900	26.33
23			Wheat feed, rice bran						
24			Linseed, rapeseed cake.....						
25			Molasses.....						
26			Minerals.....						
27	VI	300	Wheat, barley.....	45	135	27.18	3,670	7,630	25.43
28			Wheat feed, rice bran.....						
29			Grain.....						
30			Molasses.....						
31			Minerals.....						
32	Total cost	—	—	—	—	—	—	64,720	—

Footnotes:

(1) Where more than one raw material may be included in the formula at a given rate, ie in Formula I. Rice, Millet and Sorghum, the price given is the minimum price at which it is expected that one of the materials will be available. Which material it is will depend on the year and the exact location of the plant

(2) See text, Chapter 5, for explanation of raw material inclusion

— not applicable

Table 7
 Quantities and costs of raw materials used in Model III to produce poultry products
 5 tons per hour, 300 x 8-hr shifts. 2 x ½-hr stoppages per shift. 10,500 tons per year

Row	Formula no	Type of compound	Annual production tons p.a.	Raw materials	Percentage inclusion in compound	Total raw material in compound tons (c) x (e)	Price of raw material £ Sterling 1970	Total cost of raw material £ Sterling 1970 f x g	Total cost of formula £ Sterling 1970	Cost £ Sterling 1970 £ per ton i/c
		a	b	c	d	e	f	g	h	j
1	I	Chick starter September - March	735	Rice, millet and sorghum.....	65	477.75	22.68	10,840		
2				Sesame, cottonseed (dec.ext.) Groundnut cake (dec.ext.)	15	110.25	52.85	5,830		
3				Fishmeal, meat and bonemeal, bloodmeal..	9	66.15	60.47	4,000	22,400	30.47
4				Mineral-vitamin premix.....	8	58.80	25.00	1,470		
5				Molasses.....	3	22.05	12.08	270		
6	II	Chick starter April - August	526	Wheat, barley and maize.....	75	393.75	27.18	10,700		
7				Linseed and rapeseed cake.....	10	52.50	36.24	1,900		
8				Fishmeal, meat and bonemeal, bloodmeal..	5	26.25	60.47	1,590	15,300	29.14
9				Mineral-vitamin premix.....	7	36.75	25.00	920		
10				Molasses.....	3	15.75	12.08	190		
11	III	Breeder/layer feed September - March	2,730	Rice, millet and sorghum.....	75	2,047.50	22.68	46,440		
12				Sesame, cottonseed (dec.ext.) and Ground nut cake (dec.ext.).....	15	409.50	52.85	21,640		
13				Fishmeal, meat and bonemeal, bloodmeal..	3	81.90	60.47	4,950	76,750	28.11
14				Mineral-vitamin premix.....	4	109.20	25.00	2,730		
15				Molasses.....	3	81.90	12.08	990		
16	IV	Breeder/layer feed April - August	1,890	Wheat, barley, maize.....	80	1,512.00	27.18	41,100		
17				Linseed, rapeseed cake.....	10	189.00	36.24	6,850		
18				Fishmeal, meat and bonemeal, bloodmeal..	3	56.70	60.47	3,430	53,950	28.54
19				Mineral-vitamin, premix.....	4	75.60	25.00	1,890		
20				Molasses.....	3	56.70	12.08	680		
21	V	Broiler finisher September - March	2,730	Rice, millet and sorghum.....	69	1,883.70	22.68	42,720		
22				Sesame, cottonseed (dec.ext.) and ground nut cake (dec.ext.).....	15	409.50	52.85	21,640		
23				Fishmeal, meat and bonemeal, bloodmeal..	5	136.50	60.47	8,250	79,070	28.96
24				Mineral-vitamin premix.....	8	218.40	25.00	5,460		
25				Molasses.....	3	81.90	12.08	990		
26	VI	Broiler finisher April - August	1,890	Wheat, barley and maize.....	75	1,417.50	27.18	38,530		
27				Linseed and rapeseed cake.....	10	189.00	36.24	6,850		
28				Fishmeal, meat and bonemeal, bloodmeal..	5	94.50	60.47	5,710	55,080	29.14
29				Mineral-vitamin premix.....	7	132.30	25.00	3,310		
30				Molasses.....	3	56.70	12.08	680		
31	Total cost		—	—	—	—	—	—	302,550	—

Footnote:

— not applicable

Table 8
Electricity requirements and costs

		Row		Model I		Model II		Model III		Model IV	
1	Energy charge (1) ..	1.73d per kWh		0.93d per kWh		0.80d per kWh		0.80d per kWh		0.80d per kWh	
		kWh per ton	no. tons	annual cost £	kWh per ton	no. tons	annual cost £	kWh per ton	no. tons	annual cost £	kWh per ton
2	Grinding (2)	11.5	1,347	112	11.0	3,367	144	10.6	7,732	273	9.5
3	Cake-breaking (3) ..	—	—	—	—	—	—	—	—	—	5.0
4	Mixing.....	4.0	2,400	69	2.0	6,000	46	2.0	10,500	70	2.0
5	Pelleting.....	20.0	2,400	346	18.8	6,000	437	16.7	10,500	584	17.1
6	Other.....	3.9	2,400	67	4.3	6,000	100	3.6	10,500	126	4.0
7	Total energy charge	—	—	594	—	—	728	—	—	1,053	—
8	Demand charge.....			£0.388 per kVA per month.		£0.554 per kVA per month		£0.550 per kVA per month		£0.540 per kVA per month	
9	kVA demanded.....	67.58		172.25		223.0		267.0			
10	Annual demand charge.....	315		1,145		1,472		1,730			

Footnotes:

(1) Energy requirements are calculated from the formula $kWh = \frac{hP \times 0.746}{PF \times EF}$, assuming that Power Factor = 1 and Efficiency factor = 0.75
Actual kWh also depends on the proportion of time each machine is working. Prices used are derived from charges in a specific country

(2) Cereals only are ground in Models I, II and III, oilseeds are also ground in Model IV

(3) Oilseed cakes only pass through the cake-breaker

Table 9
Manpower requirements

£ Sterling 1970

Row		Model I					Model II					Model III					Model IV					
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	
1	Class of manpower (1)	1,500	450	500	400	250	2,000	450	500	400	250	2,000	450	500	400	250	2,000	450	500	400	250	
2	Annual income (2) (3) (£)	1,500	900	1,500	800	2,500	2,000	1,350	1,500	1,200	5,000	2,000	1,800	2,000	1,600	7,500	2,000	2,250	2,000	1,600	8,750	
3	Management.....	1	—	—	—	—	1	—	—	—	—	1	—	—	—	—	1	—	—	—	—	
4	Clerical.....	—	2	—	—	—	—	3	—	—	—	—	4	—	—	—	—	5	—	—	—	—
5	Grinding.....	—	—	—	1	1	—	—	—	1	1	—	—	—	—	—	1	—	—	1	5	
6	Blending.....	—	—	—	1	—	—	1	—	—	1	—	3	—	—	—	1	1	—	1	2	
7	Mixing.....	—	—	—	—	1	—	—	1	1	2	—	—	—	1	1	4	—	—	—	1	
8	Pelleting.....	—	—	—	1	2	—	—	1	3	—	—	1	1	1	3	—	—	—	—	1	
9	Warehouse.....	—	—	—	1	—	5	—	—	1	11	—	—	1	—	18	—	—	1	1	3	
10	Total employees.....	1	2	3	2	10	1	3	3	20	1	4	4	4	30	1	5	4	4	35		
11	Total payments £.....	1,500	900	1,500	800	2,500	2,000	1,350	1,500	1,200	5,000	2,000	1,800	2,000	1,600	7,500	2,000	2,250	2,000	1,600	8,750	

Footnotes: (1) A = Manager; B = Clerical; C = Supervisory; D = Semi-skilled; E = Unskilled

(2) Includes all welfare and supplementary payments

(3) Information derived from Asian country

Appendix 4

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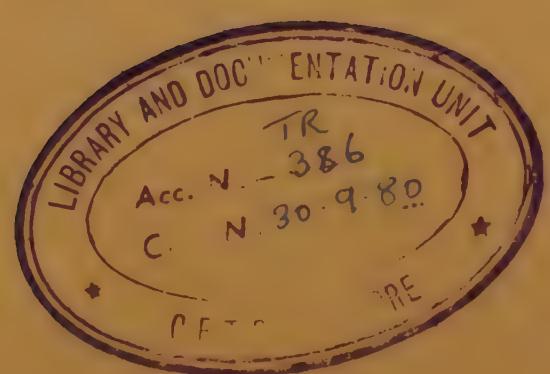
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The improvement of hand-operated groundnut decorticating machines





Tropical Products Institute

G68

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This report was produced by the Tropical Products Institute, a British Government Organisation which helps developing countries to derive greater benefit from their renewable resources.

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Introduction

There are several manufacturers of hand-operated decorticators of the semi-rotary design and this is probably the most widely used hand operated machine used in groundnut producing countries. Although extremely easy to operate, it has given variable results in different countries: sometimes it works extremely well, but in other cases it has been unsuccessful for reasons which are not immediately apparent.

The Engineering Section has carried out a series of experiments on this type of machine, using different sizes and varieties of nuts from various countries of origin. From the results obtained it became apparent that some form of feed control device and method of screen selection would improve performance and overall efficiency.

This report deals with experiments on screen selection, the development of the feeder, and results obtained during trials together with drawings of the final design evolved.

DESIGN DESCRIPTION OF THE SEMI-ROTARY DECORTICATOR

The basic design for this type of machine is common to all manufacturers with some minor variations — the following description is of the 'Kano' design (see fig. 1). This consists of an oblong steel box approximately 2ft long by 1ft wide, and 1½ft deep, open at the top and bottom. Across its centre and towards the top is fixed a 1" dia. steel shaft, on which swings a pair of steel plates mounted on a cast iron bearing. Between these plates are placed at intervals, on an arc, four cast iron shoes or beater bars, which have blunt spikes on their underside.

The semi-rotary action of these shoes is effected by swinging them backwards and forwards using a 3ft handle.

The shoes swing in an arc over a wire mesh screen, fixed to curve through 180°C the shoes can be adjusted nearer to the screen to make the decortication action more severe if required.

The nuts are decorticated by the shoe action rolling and pushing them through the wire mesh screen. There are usually available, as an extra, four different mesh sizes of screen with 3/8", 7/16", 1/2" and 5/8" square holes, but manufacturers rarely publicise their availability. If the set of four screens are not ordered specifically the manufacturer will supply the machine fitted with a 7/16" mesh. However, from results of TPI experiments it is considered essential to purchase the range of screen sizes available. At the time of writing this report the cost FOB of one machine and one screen, if purchased in batches of 100, was approximately £12, the 3 screens to make up the set was an additional £3.

SCREEN SELECTION AND RANGING EXPERIMENTS

A series of trials were conducted to ascertain the best method of selecting and ranging a set of screens. It should be noted that if only one screen size is available to

the machine the efficiency of the machine is then governed by the size and variety of nuts being processed.

To select a screen the best method found was to take a sample of the nuts to be decorticated and push them end on, through one of the screen holes. If the screen is too large, the nuts pass through without breaking the shells. If it is too small the kernels are damaged. If the shells were crushed and most kernels passed through undamaged, it was concluded to be the correct screen size required. However, the variation in size of the nuts is such that whatever size screen is used a proportion of the kernels are damaged or a proportion of nuts is not decorticated.

If several machines are available it will be more efficient to fit some with smaller screens to deal with the undecorticated portion. For example, if a 1/2" screen was found to be the size required for a particular batch, it is possible that 25% of the input would pass undecorticated. If five machines were in use then the fifth one could be fitted with a 7/16" screen to take the undecorticated factor from the other four. The results of screen ranging are given in tables 1 - 5.

REASONS FOR THE DEVELOPMENT OF THE FEED CONTROL

After experiments had been conducted at TPI one of the authors visited the Malagasy Republic in 1969 and had an opportunity to study this type of machine in operation. It was found that the efficiency of the machine could be affected in two ways:—

- a) by use of the wrong size screen as described above, and
- b) by over-feeding or feeding irregular amounts.

It was in an attempt to eliminate b) that prompted the idea of a feed control device.

If the machine is too full there is an increased kernel breakage and damage rate. It also considerably increases the effort required for the operator to move the handle backwards and forwards. (See table 6). In addition to reducing breakage, damage and manual effort, an automatic dispenser type feeder would allow the machine to be operated by one man: normally the machine is used with one man working the handle whilst another feeds the nuts.

METHOD OF DEVELOPMENT AND DESIGN

The first consideration in design was to produce a simply manufactured and inexpensive device that could be easily attached to existing machines or be supplied as an extra with new ones.

It was apparent that the feeder would have to be co-ordinated with the speed at which the handle of the machine was moved. Also the feed would require some form of regulation per stroke of the handle.

Experiments were conducted to determine the maximum and minimum throughputs of the different screen sizes per stroke of the handle. From these results the amount dispensed per stroke was determined. Once these amounts were known it only remained to develop some form of regulation. It was decided that the best form of co-ordination between feeding and decortinating would be a measuring cup coupled by means of a simple link to the operating arm.

To establish the size of the cup it was necessary to measure the weight of the kernel and shell produced when the screen was completely covered by whole nut, and after the operating handle was moved one stroke. An equivalent weight of the smallest sized whole nuts was then taken, and the volume obtained. This volume was regarded as the capacity of the cup.

The measuring cup was manufactured in the form of a quadrant of rectangular section and was mounted on a shaft which was linked to the machine handle. The hopper was mounted above the cup and its throat was shaped to form over the cup sides. The unit was mounted at one end on top of the oblong machine box.

When the cup was moved upward it filled from the hopper and when tilted forward discharged into the decorticator. A 'shut-off' plate was attached to the back edge of the cup to prevent the hopper discharging its load into the machine.

To have used different sized cups for each size of screen would have proved expensive, therefore, the linkage between the handle and cup was provided with an adjustment. By holding the handle still, the grub screw securing the cup to the linkage could be loosened and the cup moved. The effect of moving the cup forward decreased the size of the charge deposited into the decorticator and when moved backward the feed rate was increased. The 'shut-off' plate prevented the part of the hopper throat not presented in the cup, from discharging its contents, when in a forward position.

The method of using a grub screw to secure the cup in its desired position proved unreliable and slipped, thereby changing the feed rate. A modification was made by welding a disc to the cup shaft with holes drilled round the periphery, that could be aligned with a hole in the linkage arm and secured by a bolt and wing nut. No further trouble was experienced by using this method (see fig. 2).

For the purpose of feed rate tests, the decorticator was linked to a shaping machine set at 70 strokes per minute in the workshop (it was considered that 70 strokes per minute was a reasonable eight-hour per day working rate for the decorticator when manually operated).

The material used in the construction was mainly 16 SWG mild steel sheet and other parts were of 1" x 1/4" mild steel bar and material easily obtained or simply modified ie. collars were from drilled out 1/2" nuts, bearing blocks could be cut from old pieces of cast iron plate or other suitable materials.

The size of the hopper is only limited by its height for loading and its effect on the machine balance (it must be offset from the machine centre line for the handle to operate).

If welding equipment is available, the method of construction will enable any country or individual, to produce these feeders cheaply and simply.

CONCLUSION

It is considered that a feeder of the design described will be useful not only to the owner of one machine, but even more particularly to an establishment that may be using or considering using these machines in numbers on a production basis. In the latter case a saving in labour will be made, as well as a possible increase in outturn efficiency.

It is estimated that large batch production will allow the feeder to be manufactured for between £10-£12 FOB. Moreover the details and drawings given in this report should enable interested countries to manufacture feeders themselves at a lower cost.

Since this work was completed, a feeder of the TPI design has been manufactured by the Mauritius Sugar Industry Research Institute; the authors are informed that it has given satisfactory results but no data was available at the time of writing.

Appendix 1

SCREEN RANGING TRIALS

TABLE 1

Mauritius Origin NCII. Shell/Kernel ratio % = 74% Kernel

Using	Feed rate in Kg/hr	Undecort- icated	Split Kernel %	Whole Kernel % Undamaged	Whole Kernel % Damaged	Undamaged or HPS Kernel % Outturn
$\frac{5}{8}$ " Screen only	151.6	26.0	17.7	58.3	24.0	43.2
$\frac{1}{2}$ " Screen only	105.0	1.0	17.4	60.8	21.8	45.0
$\frac{5}{8}$ " to $\frac{1}{2}$ " Screen range	120.0	4.6	8.6	76.0	15.4	56.2

TABLE 2

Gambian Origin. Shell/Kernel ratio % = 76% Kernel

$\frac{7}{16}$ " Screen only	118.5	31.7	36.1	35.7	28.2	27.2
$\frac{3}{8}$ " Screen only	70.0	15.8	33.7	33.3	33.0	25.1
$\frac{7}{16}$ " to $\frac{3}{8}$ " Screen range	96.8	12.6	34.6	36.7	28.7	27.9

TABLE 3

Zambian Origin. Shell/Kernel ratio % = 74% Kernel

$\frac{5}{8}$ " Screen only	180.3	36.2	17.3	55.3	27.4	40.9
$\frac{1}{2}$ " Screen only	87.5	6.75	20.3	54.4	25.3	40.2
$\frac{5}{8}$ " to $\frac{1}{2}$ " Screen range	130.0	6.45	16.6	58.2	25.2	43.0

TABLE 4

Mauritius Origin Cabri. Shell/Kernel ratio % = 73% Kernel

$\frac{1}{2}$ " Screen only	137.9	28.2	10.0	75.0	15.0	54.7
$\frac{7}{16}$ " Screen only	66.0	8.0	11.2	74.4	14.4	54.4
$\frac{1}{2}$ " to $\frac{7}{16}$ " Screen range	123.9	2.5	9.2	75.4	15.4	55.0

Tables continued:

TABLE 5

Eritrean Origin. Shell/Kernel ratio % = 75% Kernel

Using	Feed rate in Kg/hr	Undecorti-cated	Split Kernel %	Whole Kernel % Undamaged	Whole Kernel % Damaged	Undamaged or HPS Kernel % Outturn
$\frac{1}{2}''$ Screen only	210.0	73.5	20.0	67.0	13.0	50.2
$\frac{7}{16}''$ Screen only	88.0	Nil	17.0	70.0	13.0	52.5
$\frac{1}{2}''$ to $\frac{7}{16}''$ Screen range	149.0	Nil	9.4	79.9	10.7	59.9

Calculation used for determining whole kernel undamaged outturn efficiency or possible HSP outturn was;

$$\frac{\text{Shell/Kernel ratio \%} \times \text{Whole Undamaged Kernel \%}}{100}$$

Moisture content of the batches of groundnut decorticated ranged between 5% and 7%.

TABLE 6

Trial carried out using Ethiopian Red Valencia Nuts

Test	Work Effort	Whole Kernel %	Screen Size
Machine empty	5.6 ft/lb	Damaged Percentage was not recorded	—
Machine in use under control of the feeding device	31.25 ft/lb	97.1	$\frac{7}{16}''$
Machine overloaded by not using feeder or controlled hand feeding	57.25 ft/lb	96.0	$\frac{7}{16}''$

Appendix 2



Fig. 1



Fig. 2

FEEDER FOR HAND OPERATED
GROUNDNUT DECORTICATOR

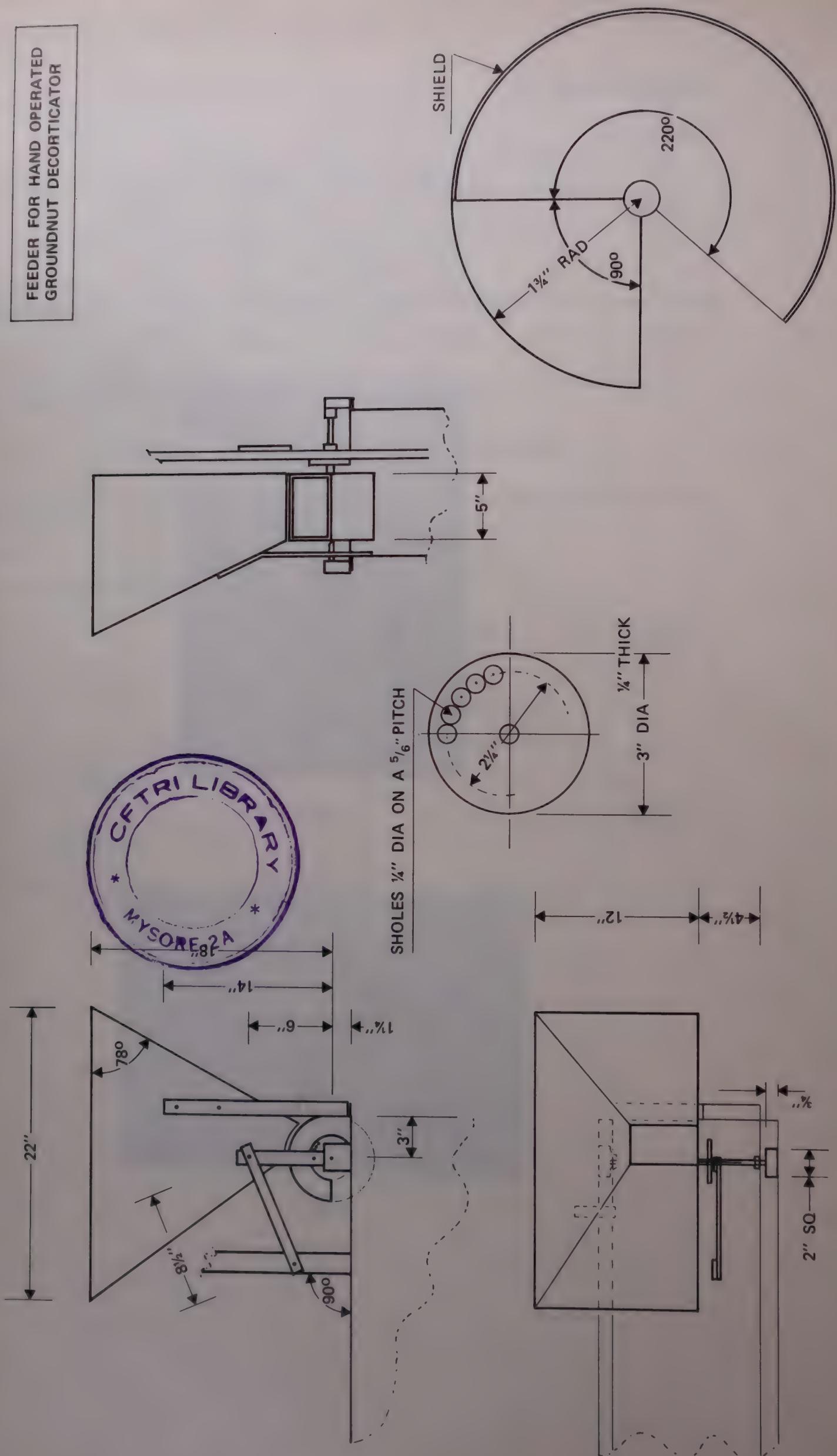


Fig. 3

The market for dehydrated vegetables with particular reference to selected Western European Countries





The market for dehydrated vegetables with particular reference to selected Western European Countries

Jacqueline Stother

This report was produced by the Tropical Products Institute, a British Government organisation which helps developing countries to derive greater benefit from their renewable resources.

It specializes in post-harvest problems and will be pleased to answer requests for information and advice. Reports such as this one are often written as the result of an enquiry.

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NOTES

1. This report is published in two parts. Part I deals in detail with the markets in the United Kingdom, the Netherlands, Belgium/Luxembourg, France and Italy and briefly at the outset with the overall world situation; the research for and writing of this part has been carried out at the Tropical Products Institute, London. Part II studies in detail the markets in the German Federal Republic, Switzerland, Austria, Denmark, Norway and Sweden; the research for and writing of this part have been carried out at the International Trade Centre, UNCTAD/GATT, Palais des Nations, 1211 Geneva 10, Switzerland, from whom Part II is available.
2. In Part I all quantities are expressed in metric tons and kilograms and values in pounds sterling (£) and new pence (p); however, US dollars equivalents are shown throughout the text (not in tables) to facilitate cross reference between the two parts of the report.
3. Import statistics for 1970 for the countries whose markets are studied in detail in Part I became available during the final stages of preparation of the report. These statistics have been shown throughout in the statistical tables of countries' imports by commodity but not in countries' imports by origin although any changes of significance have been noted in the text.

ACKNOWLEDGEMENTS

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Summary and Conclusions

1. This report is concerned with the markets for dehydrated vegetables including detailed examination of the markets in a number of Western European countries. The field of investigation excludes culinary herbs and "instant" potato flakes and granules but includes dehydrated garden peas.
2. Most dehydrated vegetables are prepared by hot-air drying processes in which the fresh vegetables are prepared and then dried in a stream of hot air. A recent development based on vapour pressure differentials permits dehydration at relatively low temperatures. Small quantities of dehydrated vegetables are prepared by the freeze-drying, or lyophilization process, in which the prepared vegetables are frozen and the water extracted by sublimation under a vacuum. A "puffing" process is also used in which the vegetables are partially dried and then puffed by a technique similar to that employed in the production of puffed cereals.
3. Vegetables for dehydration are generally grown on contract to the processors and not bought on the open market. It has been found that specialisation in the processing of one or two types of vegetables is more profitable than the production of a wide range of dehydrated vegetables.
4. Dehydrated vegetables are used chiefly in dried soups, but they are also used as a constituent in a number of food products such as canned soups and stews, fish and meat products and ready-made meals; there is a demand for dehydrated vegetables for culinary use, notably in the United Kingdom.
5. World production and exports of dehydrated vegetables are summarised. Few countries publish statistics of production, but the United States appears to be the major world producer by a very wide margin — production of dehydrated onions and garlic alone were estimated to approach 40,000 tons in 1970. Egypt is another important processor of onions and garlic. Among the European producers the Netherlands is the most important, although in recent years a large proportion of her production has been of dehydrated potatoes. Italy and France are also important producers of dehydrated vegetables, but production in Germany and Belgium is reported to be declining. A number of firms have established dehydration plants in Portugal and Spain in recent years in order to take advantage of these countries' low labour costs and long growing seasons. Dehydration industries have also been established in various East European countries, Morocco, Israel, The Lebanon, Japan, People's Republic of China, Taiwan, Kenya, Chile and Peru and in the last year or two other countries have begun the production of dehydrated vegetables including Turkey, Sudan, India and Ceylon.
6. World import statistics for dehydrated vegetables are examined. Imports into the major industrialised countries rose from 33,100 tons in 1965 to 46,300 tons in 1969, an increase of 40 per cent over the period, although if Canadian imports (which may have included "instant" potato) are ignored the increase amounted to 74 per cent. The countries of Western Europe accounted for 82 per cent of total imports in 1969, their imports having increased by 80 per cent between

1965 and 1969. The major importing countries are the United Kingdom, Germany and the Netherlands which together imported 64 per cent of world imports in 1969.

7. The break-down of import statistics by type of dehydrated vegetable varies considerably from one importing country to another. Onions are the most important of the dehydrated vegetables traded internationally, accounting for about 38 per cent of total imports into the countries showing this vegetable separately in the Trade Returns. Other vegetables traded in substantial quantities are potatoes (excluding "instant" potatoes), mushrooms and tomatoes. Vegetables of less importance include carrots, leeks, garlic, celeriac (celery root), French beans and garden peas.

8. An attempt is made to estimate net demand for dehydrated vegetables in Europe. This probably amounted to some 43,500 tons in 1969. Net demand for dehydrated onions in the United Kingdom, Germany, the Netherlands, France, Belgium and Italy amounted to approximately 12,400 tons in 1969 compared with 10,700 tons in 1968.

9. The quality requirements of European buyers are commented upon, as regards flavour, colour, cut, rehydration time, freedom from foreign matter, moisture content, bacterial count, permitted additives, trace elements and reaction to peroxidase and catalase tests. Bacterial standards appear to have posed particular problems for developing countries.

10. Ideally, dehydrated vegetables should be packed in hermetically-sealed cans or drums of tin-plate since oxidative changes lower the quality of the vegetables. However this type of packing is very expensive and now used chiefly for powders (which are very hygroscopic), when shipping to or from tropical areas or when gas-packing with nitrogen is necessary. Polyethylene has been increasingly used as a packing material in recent years since it is relatively cheap and moisture-proof; it is generally used in conjunction with fibreboard cartons and drums, cardboard cartons or multi-wall paper sacks. There is a trend towards palletization for which purpose cartons are the most suitable container. Common sizes of packs are 12 kg, 25 kg, 40 kg and 100 kg but caterers require smaller packages, usually of half a kilo to 3 kilos in weight. United Kingdom imports of some vegetables packed in air-tight containers attract a higher rate of import duty than imports in non-air-tight containers.

11. There are no phyto-sanitary regulations restricting trade in dehydrated vegetables except for a prohibition on imports of dried beetroot into Italy. However quota restrictions on imports into France limit trade with countries outside the European Economic Community (EEC). The United Kingdom imposes quotas on imports from Eastern European countries and the People's Republic of China; these are negotiated annually.

12. United Kingdom import duties on most dehydrated vegetables amount to 10 per cent *ad valorem* for imports packed in non-air-tight containers and 15 per cent *ad valorem* for vegetables packed in air-tight containers but imports from Commonwealth countries, South Africa and the Irish Republic enter duty free. Dehydrated tomatoes and leeks imported from EFTA countries also enter the United Kingdom free of duty, as do all imports of garlic and sweet peppers. The Common External Tariff of the EEC is levied at 18 per cent *ad valorem* on dehydrated onions and 16 per cent *ad valorem* on other dehydrated vegetables; dehydrated peas attract a duty of 10 per cent *ad valorem* in the United Kingdom and 4.5 per cent in the EEC. So far as internal taxes on dehydrated vegetables are concerned, none are levied at present in the United Kingdom — what the position will be regarding foodstuffs following the introduction of value-added tax in 1973 is as yet uncertain. Value-added taxes in the other countries studied range from 5.5 per cent in Italy to 14 per cent *ad valorem* in the Netherlands.

13. The level of domestic production in the United Kingdom is not known, but probably approached 2,000 tons per annum, the most important products being dehydrated peas, followed by carrots and potatoes. The United Kingdom is the major world importer of dehydrated vegetables, imports rose from an estimated

5,705 tons in 1960 to 14,574 tons valued at £6,368,600 (\$15,285,000) in 1970 and in addition imports of dehydrated peas from the Irish Republic exceeded 1,000 tons in 1969 and 1970. The major types of dehydrated vegetable imported are onions, potatoes and tomatoes; these vegetables accounted for respectively 51 per cent, 13 per cent and 7 per cent of total imports in 1970. The major supplying countries to the United Kingdom market are Egypt, Hungary, the Irish Republic and the Netherlands. No statistics of domestic exports are available but re-exports of dehydrated vegetables represent a very small proportion of total imports.

14. The structure of the United Kingdom trade in dehydrated vegetables is rather complex in that besides being sold as a raw material to food manufacturers, they are also sold for consumption as culinary vegetables to institutions and at retail level. The major buyers — principally the dried soup manufacturers — obtain most of their requirements direct from producers, buying on contract up to a year in advance. However the dried soup manufacturers probably buy less than 40 per cent of imported dehydrated vegetables — a much lower proportion than in any other European country — and therefore the "traditional" sector of the trade, importers, agents and wholesalers is of importance in the United Kingdom. Demand for dried soups is expected to increase, but at a slower rate than in recent years and demand from other manufacturers and from caterers is also expected to rise slowly. Dehydrated vegetables are bought against sample usually on a cif or "delivered" basis. Commission rates charged by importers and agents are usually of the order of 5 per cent.

15. Average cif values for various dehydrated vegetables, calculated from the Trade Returns are presented in Table 10. Since 1968 prices of most dehydrated vegetables, other than tomatoes, have shown an upward trend. This was especially true of onions which rose in price very rapidly between 1969 and 1970 as the result of rapidly increasing demand, although prices slumped in early 1971. Price ranges for a larger number of dehydrated vegetables on a landed duty-paid basis are also shown for late 1970 and early 1971. The price of *Boletus edulis* mushrooms, which are in short supply are at a historically high level at present.

16. Despite her relatively small population, the Netherlands is a major producer, exporter and importer of dehydrated vegetables. Domestic production excluding potatoes and peas exceeds 3,000 tons per annum and production of dehydrated potatoes probably amounts to at least the same figure. A very wide range of vegetables is processed, the major types being carrots, celeriac, beans, peas, leeks and cabbage. The Netherlands is third among world importers in terms of tonnage imported. Imports rose from 1,864 tons in 1960 to 6,721 tons valued at £2,435,000 (\$5,844,000) in 1970; most of the increase occurred from 1965 onwards. The major types of vegetables imported are onions, tomatoes, potatoes, carrots and leeks which accounted for respectively 46 per cent, 16 per cent, 11 per cent, 10 per cent and 6 per cent of total imports in 1970. The major sources of imports are Germany, Hungary, Egypt, Italy, the United States and Roumania. The Netherlands is the major European exporter of dehydrated vegetables; exports and re-exports rose from 2,479 tons in 1960 to 5,910 tons in 1970, much of the increase being accounted for by exports of dehydrated potates. Net demand for dehydrated vegetables other than potatoes is estimated at 6,690 tons in 1970.

17. The structure of the trade in dehydrated vegetables is still relatively simple in the Netherlands since the dried soup manufacturers dominate the market. Many of the Dutch manufacturers of dried soups supply the Belgian market as well as the domestic market, which partly accounts for the high usage of dehydrated vegetables in the Netherlands; requirements and more particularly demand for imported vegetables, are still expanding in spite of the increasing importance of canned soups in the prepared soup market. Some other manufacturers e.g. meat packers, also buy dehydrated vegetables; demand from this sector is still small, but expected to increase. Catering and retail outlets for dehydrated vegetables are extremely limited in the Netherlands at present, but catering demand is expected to show a significant increase. Dehydrated vegetables are bought against sample, either on cif or on c and f terms.

18. Average cif values for various vegetables, calculated from the Netherlands' Trade Returns are shown in Table 15. Prices for dehydrated onions showed an upward trend from 1965 to 1970 and prices for a number of vegetables rose from 1967 to 1970 although prices for dehydrated tomatoes and beans showed a downward trend.

19. The Netherlands, Belgium and Luxembourg effectively constitute a single market for dehydrated vegetables since most of the major dried soup manufacturers have plants in the Netherlands which also supply the Belgian and Luxembourg markets, thus imports of dehydrated vegetables into Belgium and Luxembourg are at a very low level. There is a limited but unquantified domestic production of dehydrated vegetables in Belgium; potatoes appear to have been the main type of vegetable processed in recent years. Imports have shown an upward trend, rising from 181 tons in 1960 to 430 tons valued at £225,400 (\$541,000) in 1970, however exports and re-exports have risen much more rapidly, from 41 tons in 1960 to 794 tons in 1970. The main types of vegetables imported are onions, potatoes and leeks, accounting for respectively 34 per cent, 17 per cent and 9 per cent of imports in 1970, tomatoes are also of some importance. The major sources of imports are the Netherlands, France, Germany and Morocco. Exports in recent years have been largely of dehydrated potatoes.

20. There is only one dried soup manufacturer in Belgium; this firm imports dehydrated vegetables direct from producers but does not expect any increase in demand. The import trade for other users is dominated by a single firm; outlets in Belgium are limited but demand from manufacturers and catering concerns is expected to increase. The average cif values of imports, as calculated from the Trade Returns, are shown in Table 19; prices appear to be rather higher than those prevailing in the United Kingdom and the Netherlands.

21. France is a relatively small importer of dehydrated vegetables but has a sizeable domestic processing industry which is protected from competition from producers outside the EEC by an import licencing system. Domestic production amounted to 3,880 tons in 1969/70 compared with 3,100 tons in 1968/9, the major types of vegetables processed being potatoes, tomato flakes and powder, onions, asparagus, carrots and garlic. Imports rose from 304 tons in 1960 to 1,817 tons valued at £1,551,700 (\$3,724,000) in 1970. Onions are probably the major type of vegetable imported, accounting for 21 per cent of imports in 1970, other types of vegetables imported include *B. edulis* mushrooms, carrots, tomatoes and leeks. Exports and re-exports have declined since 1965 but amounted to 1,256 tons in 1970. Net demand for dehydrated vegetables is estimated at 3,400 tons in 1968 and 4,550 tons in 1969.

22. The import licencing system in France has prevented the development of a specialised trade in dehydrated vegetables. The dried soup manufacturers buy direct from domestic or EEC producers and those firms eligible for import licences (which depend on a company's exports) may also import directly from third countries. General importers also obtain licences from time to time but Moroccan and Israeli producers sell through agents (both countries enjoy special import quotas). Manufacturers of dried soups continue to be the major buyers of dehydrated vegetables, probably accounting for about 80 per cent of estimated net demand. It is expected that sales of dried soups will continue to rise. Other food manufacturers use rather limited quantities of dehydrated vegetables and the catering and retail markets have not been developed to any extent. Average cif values of imports as calculated from the Trade Returns are shown in Table 24. Average prices for both onions and other vegetables showed a downward trend until 1969, but recovered to some extent in 1970.

23. Like France, Italy is a relatively minor importer of dehydrated vegetables, but of some importance as an exporter. Estimates of domestic production vary from 1,000 tons to 3,500 tons. The major types of vegetables processed are tomatoes, cauliflowers, leeks and sweet peppers. Imports showed a strong upward trend from 1960 to 1969, rising from 285 tons in 1960 to 1,632 tons in 1969 but the tonnage imported fell to 1,445 tons valued at £1.25 million (\$3.00 million) in 1970. The

major types of vegetables imported are mushrooms and truffles and onions, the latter accounting for 18 per cent of imports in 1970 and the former category for an estimated 65 per cent (separate figures for mushrooms and truffles are not available after 1967). The major supplying countries are Yugoslavia, the Netherlands, Roumania, Egypt, Bulgaria and Germany. Exports and re-exports showed a rising trend from 1960 to 1963, then declined again and in 1970 stood at 809 tons. Net demand for dehydrated vegetables is probably of the order of 1,600 to 1,900 tons per annum.

24. Most of the large quantities of mushrooms and truffles imported into Italy are probably sold to food manufacturers who are the major buyers of most other dehydrated vegetables but also to caterers. However the prepared soup industry is small compared with that in most other European countries. Average cif values of dehydrated vegetables imported into Italy as calculated from the Trade Returns are shown in Table 28. The average price for dehydrated onions showed a downward trend from 1963 to 1966 before rising again.

25. An extrapolation of present import trends to 1975 suggests that imports into the five markets studied in detail in this report will increase by 19 per cent over the 1970 figure at rates varying from 13 per cent for the United Kingdom to 61 per cent for Italy. Imports of dehydrated onions will increase rather more slowly than imports of other vegetables.

26. It is always easier for new producers to enter an expanding market than a static one since it is not necessary to oust established suppliers from the market and any products competitive in price and quality should find a sale.

27. The types of vegetables for which demand is strongest at present (1971) are *B. edulis* mushrooms and asparagus; however, most entrants to the market begin by producing dehydrated onions since this item dominates the dehydrated vegetable market. The current position for dehydrated onions is one of over-supply. This situation is not likely to persist, although a return to the excessively strong demand situation and high prices of 1969 and 1970 is not expected. Prices above a level of approximately £0.45 per kilo ldp (\$1.06 per kilo) depress demand from manufacturers able to substitute fresh onions in their products.

28. A number of vegetables for which demand is considerable nevertheless pose certain problems for new producers, for example potatoes are a low-priced commodity and the raw material is probably more cheaply produced in the cool temperate climate of Northern Europe than in warmer climates. Tomato powder, another important commodity, is produced by spray-drying rather than in conventional air-drying plant.

29. At present there is very little demand for freeze-dried vegetables in the European markets studied in this report because of their high cost and the improvement in the quality of air-dried vegetables in recent years. However some manufacturers have shown their willingness to pay a small premium of about 5.5p per kilo (\$0.13 per kilo) for puffed vegetables which reconstitute quickly.

The market for dehydrated vegetables with particular reference to selected Western European Countries

*Part I United Kingdom, Netherlands, Belgium/Luxembourg, France and Italy.

Introduction

This report is concerned with the markets for artificially dehydrated vegetables in various Western European countries.

The field of investigation covers those vegetables imported under BTN trade classification 07.04 and thus excludes "instant" potato flakes and granules (BTN 11.03) and ground *Capsicum grossum* or paprika (BTN 09.04). Two items included in BTN category 07.04, horseradish and culinary herbs, are not discussed in this market study since the trade does not normally consider these products to be dehydrated vegetables (although trade statistics include these items). One vegetable not included in category 07.04 which is considered in this report is dehydrated garden peas (as distinct from field-dried peas) imported under trade category 07.05.

The markets examined in this study are those of the member countries of the European Economic Community (EEC) and the European Free Trade Association (EFTA), with the exception of Portugal which cannot be considered an industrialised country but is a considerable exporter of dehydrated vegetables. Part I of the report considers in detail the markets of the United Kingdom, the Netherlands, Belgium, France and Italy. Part II covers the German Federal Republic (Germany), Switzerland, Austria, Denmark, Norway and Sweden.

Dehydrated vegetables have been produced in small quantities since the nineteenth century; dehydrated carrots and potatoes were supplied to British naval expeditions in the mid-nineteenth century and dehydrated vegetables have been produced in sizeable quantities during subsequent wars, primarily for consumption by the armed forces, but also for civilian use. Since the quality of these products when rehydrated compared unfavourably with fresh vegetables or other types of processed vegetables, their usage declined rapidly after each war. However, the processing techniques employed in the production of dehydrated vegetables have been improved greatly since the end of World War II, particularly since the late nineteen-fifties, and as a result the quality of dehydrated vegetables has much improved. At the same time the demand for convenience foods has been increasing and dehydrated vegetables have benefited accordingly.

The main advantages of dehydrated vegetables are that they are easy to store, being lighter in weight and smaller in bulk than fresh or other processed vegetables; they are cheap to pack compared with canned goods, they do not require refrigerated storage as do frozen vegetables and the contents of a container can be used some time after opening provided they are not rehydrated. Also dehydrated vegetables have certain applications (e.g. dried soups and meals) for which other types of processed vegetables would not be suitable.

* See 'Notes' on p.iii.

The main disadvantages are that dehydrated vegetables are unattractive in the dry state because they are dry, brittle and often less colourful than fresh vegetables; unless cut into very small pieces or freeze-dried they take longer to cook than frozen or canned vegetables since they have to be rehydrated as well as cooked; they are not sterile as canned products are and the quality of dehydrated vegetables deteriorates gradually as a result of chemical, particularly oxidative and colour changes, although suitable packing and storage conditions reduce the rate of deterioration very markedly.

Dehydrated vegetables are produced by several processes, the most widely used being hot-air processes, although freeze-drying (lyophilization) and "puffing" processes have been used increasingly in recent years and it is reported that within the last two years a variation on the air-drying process has been developed in Rhodesia based on vapour pressure differentials which permits dehydration at relatively low temperatures (43°C) (1). The initial preparation of the vegetables is the same for all types of processing — the raw vegetables are washed and trimmed before slicing or dicing into conveniently small pieces for drying. Most vegetables are then blanched in hot water or steam and some are sulphited before being dried. The conventional hot-air drying process utilizes a stream of hot air passing over and through the layers of vegetable pieces. An improved process for air-drying peas involves pricking or "scarifying" each pea, which assists dehydration and accelerates rehydration. Dehydrated diced vegetables may be ground to a powder after drying, but tomato powder is invariably produced from tomato puree and is generally spray-dried — a completely different process.

In the freeze-drying (lyophilization) process the prepared vegetables are frozen and the water is extracted in the solid (ice) state by sublimation under controlled conditions of temperature and vacuum. The freeze-dried product retains its original size and shape and has a very low moisture content, while rehydration is rapid and the rehydrated product resembles the fresh vegetable more closely as regards colour, flavour and texture than do most other forms of dehydrated vegetables. Freeze-drying is however an expensive process and only small quantities of vegetables are processed by this method, although it is used more widely for the dehydration of meat and fish. The types of vegetables which are freeze-dried are chiefly those used as garnishes, for example asparagus tips and champignon mushrooms, since for this purpose eye-appeal is very important and cost less so.

For the "puffing" process the vegetables are partially dried by the conventional air-drying method before transferred to vacuum chambers where they are puffed by sudden release of the vacuum — a technique similar to that employed in the production of puffed cereals. This type of dehydration is especially suited to the processing of carrots and other root vegetables which normally take a relatively long time to rehydrate and cook. The puffing process improves rehydration and cooking time and costs little more than the conventional drying process.

The newest dehydration process appears to be a variation on the air-drying process and is based on the principle of vapour pressure differentials, using air circulated around the vegetables at relatively low temperatures to "sweat" the water from the food. It is reported that this method of dehydration prevents a pedicle (crust) forming on the outside of the pieces of food and that the low temperatures have less effect on the flavour, texture, colour and vitamin contents of vegetables than do the higher temperatures used in conventional hot-air drying methods. The running cost of processing is said to be very low, approximately 0.6p (1.4 cts) per kilo for most vegetables (2).

When establishing a dehydration industry considerable thought should be given to the procurement of fresh vegetables for dehydration. In most countries vegetables for dehydration are grown almost exclusively on contract to the processors. The contracts are made up to a year in advance and cover such aspects as acreage, planting periods, varieties of vegetables (seed is often supplied), field inspection, stage of maturity for harvesting, delivery dates, grading and prices. To operate a dehydration plant efficiently, a constant supply of vegetables is required and this involves considerable organisation — buying in supplies from the fresh vegetable

market is rarely practicable since varieties grown for the fresh market may be unsuitable for processing and continuity of supply cannot be assured. It is usually found that specialisation in processing one or two vegetables is more profitable than production of a wide range of dehydrated vegetables. Ideally a dehydration factory should handle only one type of vegetable over long periods or even throughout the year, so as to avoid the necessity of cleaning down all the machinery and altering the grading and cutting settings etc., when changing from one vegetable to another. In the United States one very large firm produces only onion and garlic products, using the eight months harvesting season in California to best advantage. Dehydration plants in Kenya and Portugal have drastically reduced the number of vegetables dehydrated to three or four, although these countries have climatic conditions suited to the growing of a very wide range of vegetables.

Uses of Dehydrated Vegetables

Dehydrated vegetables are used chiefly as a constituent in various food products, i.e. they are sold to manufacturing concerns as an industrial raw material and demand for dehydrated vegetables is a function of the demand for these food products. However there is also a demand for dehydrated vegetables for use as culinary vegetables, both by large catering concerns — institutions and industrial canteens — and for domestic use.

The major use for dehydrated vegetables is in the manufacture of dried soups — once virtually the sole outlet for these products, but now declining in relative importance as other applications including use in canned soups and stews, baby foods, fish meat and bakery products and more recently in dried "ready-meals" have been developed.

For the purpose of this report the market sectors which affect demand for dehydrated vegetables are four: viz dried soup manufacturers, other food manufacturers, the catering industry and the retail trade in dehydrated vegetables. This division is dictated by the pattern of trade which has evolved and it is important for a new producer attempting to compete in the market to understand the differences between each sector. Obviously the division would be different from other view points: for example a soup manufacturer thinks of the market for his products as being divided between industrial caterers, institutional caterers, commercial caterers and retail outlets.

So far as possible both merchants and users were consulted in the course of this survey. Since there are relatively few dried soup manufacturers, it was possible to contact a majority of the users in this class. The number of users or potential users in other manufacturing and in catering outlets is very large and it was not possible to consult a representative sample. Retail outlets obtain supplies largely from food manufacturers.

The important division of outlets from the point of view of the overseas producer is between the dried soup manufacturers who buy a large proportion of their supplies direct and other users who buy most of their requirements from importers and agents.

As might be expected, the different market sectors account for varying proportions of demand for different dehydrated vegetables. Dried soup manufacturers are virtually the only buyers of asparagus, tomatoes, celeriac and mushroom powder; potatoes are bought chiefly by other food manufacturers (for stews, Knodel, bakery products etc.) and peas and green beans are sold chiefly for culinary purposes in the catering and retail sectors. On the other hand, dehydrated onion slices and pieces are sold to all four market sectors.

World Production and Exports of Dehydrated Vegetables

Production of dehydrated vegetables is chiefly concentrated in the industrialised countries of Europe and North America, but in recent years the increasing cost of raw materials and labour has put these countries at a disadvantage compared with producers in Southern Europe, Northern Africa and Asia.

Unfortunately relatively few producing countries publish statistics of dehydrated vegetable production, in some cases (e.g. the United Kingdom) this is because production is limited to one or two firms and publication of the data would reveal too much to the competing firms.

According to trade estimates, the **United States** is the major world producer of dehydrated vegetables by a very wide margin. Production of dehydrated onion and garlic products alone were estimated to approach 40,000 tons in 1970. Production has been increasing since the late nineteen-fifties and the United States produces a very wide range of vegetables, the most important after onions and garlic being sweet peppers (*capsicum*). According to the 1963 Census of the Dehydrated Food Industry more than 70 per cent of the United States' dehydration establishments were situated in California. Dehydrated vegetables produced in the United States are of very high quality, but are generally considerably more expensive than supplies from other producing countries, thus exports form a very small proportion of total production and are made principally to Canada.

Egypt is another important processor of onions and garlic, production is currently estimated at about 5,000 tons per annum and is expected to increase to 7,000 tons by 1975 (3). Apart from onions and garlic the only other vegetable processed in any quantity is leek. Production is aimed at the export market since there is practically no domestic demand.

Among the European producers the **Netherlands** is undoubtedly the most important, although in recent years a large proportion of her production has been of dehydrated potatoes, for which no statistics are available. Production of other dehydrated vegetables fell from 5,000 tons in 1963/4 to 2,100 in 1967/68 (4) but is currently at the 3,000 tons level. **Italy** and **France** are also important producers of dehydrated vegetables, estimates of Italian production range from 3,500 tons in 1968 and 1969 to only 1,000 tons in 1970; French production was 3,900 tons in 1969 and is thought to be following an upward trend. The **Irish Republic** has only recently become a major producer of dehydrated vegetables; no production estimates are available, but exports have risen strongly in recent years. It is reported that production in **Germany** and **Belgium** has declined in recent years, owing to increasing costs; on the other hand German firms (among others) have established dehydration plants in **Portugal** and **Spain** in order to take advantage of these countries' low labour costs and long growing seasons. Portugal is now one of the major suppliers of dehydrated tomatoes.

The **Moroccan** dehydration industry also specialises in the production of tomato products and smaller quantities of peppers (*capsicum*) are processed. There are plans to expand this industry. In the Middle East, **Israel** and the **Lebanon** have established dehydration industries. Israel processes quite a wide range of vegetables, notably carrots, leeks and peppers but the Lebanon produces dehydrated onions almost exclusively.

There are established dehydration industries also in Japan, the People's Republic of China, Taiwan, Kenya, Chile and Peru. In the last year or two several countries have begun the production of dehydrated vegetables, including Turkey, Sudan, India and Ceylon and it is reported that a large plant is to be set up in Rhodesia, using the new vapour pressure differential process developed there (5); however, the last country cannot be a serious competitor on world markets unless the political situation there is resolved.

Exports of dehydrated vegetables for the years 1965 to 1969 are summarised in Table 1 for those countries where information is available. Total known exports rose from about 21,200 tons in 1965 to 30,500 tons in 1969, an increase of 44 per cent. The Netherlands has been the major world exporter since 1967 closely followed by the United States; in 1969 these countries each accounted for 22 per cent of known world exports. The other major exporting country is Egypt, who supplied 26% of known world exports in 1965 but only 16 per cent in 1969. Other important exporting countries include Germany, the Irish Republic, Lebanon, Israel, Morocco and Portugal. It should be noted that no export statistics are available for East European countries — undoubtedly important exporters of dehydrated vegetables — and that exports from Germany and the Netherlands include substantial re-exports of onions and mushrooms of East European origin.

Table 1
World exports of dehydrated vegetables 1965/69
Metric Tons

	1965	1966	1967	1968	1969
Netherlands	3,140	3,317	5,731	6,137	6,766
Germany	726	1,516	1,716	1,835	2,291
France	1,748	1,280	1,050	920	835
Italy	625	598	603	674	828
Belgium	113	229	308	321	505
Switzerland	150	265	615	742	681
Denmark	68	40	27	54	42
Irish Republic	(300)	(880)	(940)	(1,330)	(1,960)
Portugal	105	256	732	1,083	1,005
Egypt (a)	5,504	4,676	4,539	4,499	4,801
Lebanon	2,278	2,909	1,075	1,613	60
Israel	1,739	1,753	1,348	898	1,477
Morocco	520	665	880	1,107	1,295
Kenya	102	117	219	595	450
United States	3,404	4,546	5,199	5,530	6,595
Japan	434	578	475	473	660
Australia (a)	22	44	76	54	53
South Africa	80	113	66	12	9
TOTALS	21,211	23,935	25,638	27,880	30,458

() from importing countries' Trade Returns

(a) 12 months ending 30 June of year shown

Sources: Officially published Trade Statistics

Table 1 shows that exports from most supplying countries rose during the period 1965 to 1969; the increase in exports from the Irish Republic and Portugal was particularly rapid, amounting to approximately 550 per cent and 850 per cent respectively. Countries whose exports showed a downward trend or tendency were France, Denmark, Egypt, Lebanon, Israel, and South Africa. Western European countries' share of the known export trade amounted to 31 per cent in 1965 and 49 per cent in 1969, however the Netherlands' and Germany's exports include a sizeable proportion of re-exported produce of East European origin.

Fairly detailed information regarding the types of dehydrated vegetables exported is available in the Trade Returns of only very few certain countries, notably the Netherlands (onions, potatoes, carrots, French beans and mixed vegetables shown in separate categories) and Israel (onions, beetroot, carrots, potatoes and cabbage and cauliflower shown separately). Egypt shows exports of onions and garlic and Lebanon exports of onions — in both cases these vegetables comprise the bulk of exports. The Portuguese Trade Returns have separate categories for tomatoes and garlic. The EEC countries all show exports (including re-exports) of onions separately while the Scandinavian countries show exports of potatoes and garlic in separate categories. Owing to the variation in the degree of breakdown of types of vegetables it is very difficult to assess their relative importance on the world market from export statistics, nevertheless it is obvious that onions comprise a substantial proportion of the total trade.

World Imports of Dehydrated Vegetables

Imports of dehydrated vegetables into the major importing countries are summarised in Table 2 for the years 1965 to 1969. So far as possible the figures in the table exclude imports of "instant" potato flakes and granules (the United Kingdom import totals have been adjusted to exclude imports assumed to be of "instant" potato). However no adjustments have been made to allow for re-exports of imported produce which means there is an element of double-counting.

Imports into the major industrialised countries listed in Table 2 rose from about 33,100 tons in 1965 to 46,300 tons in 1969, an increase of 40 per cent over the period. However if Canadian imports are ignored (since these were abnormally high in 1965 and 1966, and possibly included imports of "instant" potato powder in those years), imports rose from about 25,100 tons in 1965 to 43,600 tons in 1969 – an increase of 74 per cent. This increase in demand is largely due to increased consumption of packet soups in Western Europe.

Table 2
World imports of dehydrated vegetables 1965-69
Metric Tons

	1965	1966	1967	1968	1969
Germany	4,731	5,097	8,650	10,607	11,595
Netherlands	3,190	4,241	4,208	4,687	5,690
Italy	840	946	1,476	1,542	1,632
France	625	756	1,162	1,264	1,502
Belgium	226	182	229	287	504
United Kingdom (8,181)	(8,835)	(10,671)	10,634	12,574	
Switzerland	1,641	1,959	2,093	2,029	2,009
Austria	638	645	746	846	858
Sweden	441	476	620	805	850
Norway	447	422	413	461	500
Denmark	128	194	221	289	324
Finland	58	116	62	100	n.a.
United States	2,624	1,739	2,198	2,735	2,216
Canada	8,048	9,214	2,265	3,296	2,715
Japan	484	1,094	1,952	2,775	2,418
Australia (a)	520	741	1,010	759	918
South Africa	316	229	257	463	n.a.
TOTALS	33,138	36,886	38,223	43,579	46,305

() TPI estimates n.a. Not available

(a) 12 months ending 30 June of year shown

Sources: Officially published Trade Statistics.

It may be seen from Table 2 that the countries of Western Europe together account for the major proportion of world imports – 82 per cent of the total in 1969 – and imports into this group of countries rose more rapidly than imports as a whole – by 80 per cent between 1965 and 1969. The major importing countries in Western Europe are the United Kingdom, Germany and the Netherlands which together imported 64 per cent of world imports in 1969. The relative importance of these three import markets changed over the period 1965 to 1969 as imports into Germany and the Netherlands rose by 145 per cent and 78 per cent respectively compared with a 51 per cent increase in United Kingdom imports. However it should be noted that Germany and the Netherlands (especially the former country) have a considerable re-export trade in dehydrated vegetables of East European origin, whereas the United Kingdom has a relatively small re-export trade.

Imports into most Western European countries showed a rising trend during the period under review, but imports into Switzerland appear to have stabilised at around 2,000 tons per annum. Among the non-European importing countries, only Japan has increased her imports very rapidly; imports into the United States and Canada have fluctuated from year to year as have imports into Australia and South Africa though the underlying trend for the last two countries has been slightly upwards.

Types of Dehydrated Vegetables imported

Unfortunately the break-down of import statistics by type of any dehydrated vegetable varies considerably from one importing country to another. Data are available from various countries for onions, potatoes, tomatoes, mushrooms and garlic and in 1970 three countries (the United Kingdom, the Netherlands and Belgium) introduced a category for leeks, while the Netherlands and Belgium introduced one for celery and celeriac and the Netherlands also showed carrots and French beans separately for the first time. There is some conformity of statistical presentation within trading blocks — for instance all the EEC countries have a separate import category for onions and the Scandinavian countries show imports of garlic in a separate category. However, estimation of the relative importance of various vegetables on a world-wide basis poses considerable problems. Nevertheless it can safely be assumed that onions are the major dehydrated vegetable traded internationally and that potatoes (excluding "instant" potatoes), mushrooms, tomatoes and carrots are all of moderate importance.

Onions:-

Dehydrated onions are traded in two forms — kibbled or sliced onions and onion powder. Kibbled onions are used in dried soups, as a substitute for fresh onions in many canned foods and in the catering and retail fields while onion powder is used as a flavour constituent in a very wide range of foodstuffs.

Seven countries — the United Kingdom, Germany, the Netherlands, France, Belgium, Italy and Australia, show dehydrated onions in a separate import category. These countries imported a total of 11,492 tons of onions in 1968 and 13,365 tons in 1969 which represented about 38 per cent of these countries' imports of all dehydrated vegetables in those years. The importance of onions as compared with other dehydrated vegetables varies from one importing country to another — from close on 50 per cent in the United Kingdom and the Netherlands (both major importers) to less than 20 per cent in Italy — a relatively small market. Unfortunately it is not possible to estimate imports of onions into the countries which do not show this vegetable in a separate category, but many of these countries are in any case, relatively small markets. The United States' Trade Returns showed imports of dehydrated onions until 1964; imports fluctuated between 190 and 690 tons, averaging 481 tons over the five years 1960 to 1964. Since the United States is the major world producer of dehydrated onions, it seems unlikely that imports have risen since 1964.

In 1968 and 1969 the major supplying countries to the seven countries listed above were in order of importance, Egypt, Hungary, the United States, Lebanon and Roumania followed by Bulgaria, the Netherlands and Germany (re-exports of East European origin), USSR, Sudan and the People's Republic of China. The relative shares of these supplying countries are shown below:-

	1968	1969
Egypt	24%	27%
Hungary	27%	24%
United States	10%	13%
Lebanon	9%	8%
Roumania	10%	6%
Bulgaria	7%	6%
Netherlands	2%	4%
Germany	2%	2%
USSR	2%	1%
China	1%	1%
Sudan	-	2%

Preliminary data for 1970 suggest that the United States was the major supplier in that year, owing to a shortage of supplies from Egypt and East European

countries when demand was rising strongly. It is interesting to note that several new supplying countries have entered this market in recent years, notably, Sudan, India and Algeria.

Potatoes:-

Dehydrated potatoes are imported in the form of strip, dice and powder; this vegetable is used to a small extent in dried soups but to a greater extent in canned soups and stews etc., bakery products e.g. Cornish pasties and meat pies and the manufacture of "knodel", or potato dumplings.

Import statistics are available for the United Kingdom, Denmark, Norway and Austria and in 1970 also for the Netherlands and Belgium. Imports into the first four countries amounted to 1,050 tons in 1968 and to 1,370 tons in 1969, the United Kingdom accounting for the bulk of imports. However, export statistics for the Netherlands suggests that Germany is by far the largest market for dehydrated potatoes, taking 3,103 (89%) tons of the Netherlands' exports in 1968 and 3,672 (92%) tons in 1969; the balance of the Netherlands' exports goes mainly to other West European countries with only the United Kingdom (with 124 tons in 1968) and Switzerland (with 110 tons in 1969) topping the 100 ton mark. The Netherlands itself is quite an important market, judging by data for 1970 when she imported 728 tons.

As regards supplying countries, the Netherlands would appear to be the major exporter, followed by the Irish Republic, Germany, Belgium, France, Israel and the United States.

It is interesting to note that the Netherlands and Germany are both importers and exporters of dehydrated potato products. The reason for this probably stems from price and quality differences and there may also be some re-export trade.

Tomatoes:-

Dehydrated tomatoes are traded chiefly in the form of powder (made from tomato puree) but also in so-called "flakes" i.e. diced whole tomatoes (excluding the seeds). Virtually all dehydrated tomatoes are used in dried soups but small quantities are also used for flavouring and garnishing purposes in canned foods and in ready-meals.

Until 1970 only the United Kingdom and Australia showed imports of dehydrated tomatoes separately in their Trade Returns. However, the Netherlands introduced a separate category in 1970 and estimates of her imports are available for earlier years. Estimated imports into the United Kingdom, the Netherlands and Australia amounted to 2,049 tons in 1968, 1,967 tons in 1969 and 2,200 tons in 1970.

The main supplying countries are Morocco, Portugal, Italy and Switzerland. Morocco is the major supplier to the United Kingdom followed by Portugal while Italy is the chief supplier to the Netherlands' market (presumably because of EEC tariff preferences) and imports from France (possibly of Moroccan origin) are second in importance.

Mushrooms:-

There are two main types of dehydrated mushrooms traded internationally, firstly the *Boletus edulis* type which is produced almost exclusively in Eastern Europe and has a strong mushroom flavour; this type of mushroom is traded in kibbled and powdered forms and is used principally in mushroom soups and for other purposes when a mushroom flavour is required. Champignon mushrooms, on the other hand, are usually sliced, they are much milder in flavour and used chiefly for garnishing purposes.

Again the cover of import statistics is incomplete. Italy showed this product in a separate category until 1967, Germany first introduced a category in 1969 as did the Netherlands in 1970; Australia and the United States have shown imports of mushrooms separately for a longer period.

The major importing country would appear to be Italy, followed by Germany and the United States; the Netherlands and Australia are less important markets. Imports into these five countries were estimated to be of the order of 2,500 tons in 1969, but German re-exports amounted to 260 tons in that year.

The main sources of *B. edulis* mushrooms are Yugoslavia, Roumania and Bulgaria while Japan, Taiwan, Hong Kong, The People's Republic of China and France supply champignon mushrooms. Chile is an important supplier to the United States' market and also supplied Germany in 1970, presumably with champignon-type mushrooms.

Garlic:-

Dehydrated garlic is traded almost entirely in powdered form, although chopped and "granulated" garlic is also available. Garlic is used as a flavouring in a wide range of food products, especially meat products.

The Scandinavian countries (Denmark, Finland, Norway and Sweden) all have a separate import category for dehydrated garlic and estimates are available for the Netherlands. Imports into these five countries amounted to about 160 tons in 1969. The United States' Trade Returns had a separate category until 1964 — imports generally ranged from 100 to 200 tons per annum. It has been estimated that United Kingdom imports amounted to about 150 tons in 1970. Germany would also appear to be a major importer.

The main exporting countries seem to be Egypt and Portugal (judging from these countries' export returns); other suppliers include the United States, the People's Republic of China, Japan, Italy, Spain and several East European countries.

Carrots:-

Among the other types of dehydrated vegetables for which statistical data are limited, the most important would seem to be carrots. Carrots are traded chiefly in the form of dice or slices, but also as flakes and powder; they are used in dried soups, canned foods and as a culinary vegetable. Import estimates are available for the Netherlands and export data for the Netherlands and Israel. The main import markets would appear to be the United Kingdom, the Netherlands and Germany, followed by France, Switzerland, Italy and the United States. The major exporters are Israel, the Netherlands and Kenya — these three countries together exported some 1,400 tons of dehydrated carrots in 1969, Israel accounting for half the total. Other suppliers include Germany, Roumania, the USSR and the United States.

Leeks:-

Statistics for trade in leeks were not available before 1970 when the Netherlands and Belgium introduced a separate trade category and the United Kingdom introduced a category for "leeks and garlic". Estimated imports of leeks into these three countries were 690 tons in 1970. Leeks are traded chiefly in the form of flakes, although also as powder — their main use is for dried soups. The major importers appear to be the Netherlands and the United Kingdom, lesser importers include France, Belgium, Germany and Switzerland. The major supplying countries are the Netherlands, Germany, Portugal, Yugoslavia, Hungary, Bulgaria, Roumania, Kenya, Egypt and Italy, other exporters include Israel, Belgium, the

Celeriac:-

Celeriac (celery root) traded as dice, slices or powder is of fairly minor importance, used chiefly for soups and only the Netherlands and Belgium have a separate trade category for this vegetable. In 1970 imports into these two countries totalled 136 tons, almost entirely into the Netherlands and exports totalled 157 tons, also chiefly from the Netherlands. The main supplying country was Hungary, followed by Yugoslavia, and the main import markets were Germany, followed by the United Kingdom and Switzerland.

French Beans:-

French beans are dehydrated in various cuts e.g. cross-cut and length-wise slices. Their chief use is as a culinary vegetable. Until 1967 the United Kingdom had a separate trade category for this vegetable packed in air-tight containers; imports fell from 187 tons in 1963 to only 13 tons in 1967 (reportedly because of increasing domestic production): the main suppliers were South Africa, and until 1965, Rhodesia. In 1970 the Netherlands introduced a separate import category for beans: imports amounted to 39 tons, chiefly from Belgium and Germany. Export data for the Netherlands are available from 1960 onwards; from 1967 to 1969 exports amounted to about 280 tons per annum. Germany is the major market, followed by the United Kingdom and Austria. Switzerland was an important buyer at one time, but exports to this country were limited from 1968 onwards. In recent years France and Sweden have become markets of some importance.

Net Demand for Dehydrated Vegetables

In the absence of production data for many European countries, it is difficult to make reliable estimates of net demand for dehydrated vegetables for individual countries. Nevertheless it is possible to make a rough estimate of net demand for broad groupings of countries in recent years, as shown in Table 3 below:-

Table 3
Estimated Net Demand for Dehydrated Vegetables in Europe

	1965		1969	
	Net Imports	Domestic Production	Net Imports	Net Demand
EEC (Germany, Netherlands France, Italy & Belgium)	3,260	15,800	9,698	25,500
Austria, Denmark, Sweden Norway & Finland	1,644	negligible	2,590	2,600
Switzerland	1,491	n.a.	1,328	n.a.
United Kingdom	(8,045)	n.a.	12,290	n.a.

() TPI estimate

n.a. not available

The "net imports" figures are obtained by subtracting the quantities exported from the quantities imported. It is evident from the table that net imports have increased substantially except into Switzerland. It is believed that production in the EEC countries has increased relatively little since 1965 – increasing production in some countries, notably France and the Netherlands, being balanced by declining production in others. Domestic production in the second group of countries is very limited. Unfortunately no information is available concerning production in Switzerland and the United Kingdom, although it is believed that production in the

latter country has increased somewhat. If domestic production in these two countries is assumed to have amounted to some 2,000 tons in 1969, net demand for dehydrated vegetables in Western European countries amounted to some 43,500 tons in that year.

Imports definitely accounted for a larger proportion of net demand in 1969 than in 1965 (except possibly in Switzerland) and it is expected that this trend will continue.

Owing to the lack of appropriate data it is not possible, except for onions, to assess the net demand for individual vegetables. Domestic production of onions is now significant only in France and Table 4 below shows the estimated net demand for this vegetable in the EEC countries and the United Kingdom in 1968 and 1969.

Table 4
Estimated Net Demand for Dehydrated Onions in Certain Countries

	1968				1969			
	(1) Domestic Production	(2) Imports	(3) Exports	Net Demand	(1) Domestic Production	(2) Imports	(3) Exports	Net Demand
Germany	—	3,472	281	3,191	—	3,446	305	3,141
Netherlands	neg.	2,340	566	1,774	neg.	2,789	780	2,009
France	606	402	29	979	600	304	31	873
Belgium	—	83	12	71	—	160	58	102
Italy	—	148	7	141	—	194	12	182
United Kingdom	—	4,725	160	4,565	—	6,150	89	6,061
				10,721				12,368

Sources (1) Syndicat des Deshydrateurs
(2) & (3) Officially published Trade Returns

QUALITY REQUIREMENTS

The major users of dehydrated vegetables i.e. the soup manufacturers, have evolved specifications which are suited to their own products as regards, cut, moisture content, rehydration time etc and these specifications vary from one manufacturer to another. Buyers of dehydrated vegetables for culinary purposes generally have less stringent specifications. Comments on some of the more important quality factors are listed below:-

a. Flavour

Judgement of flavour is obviously subjective and difficult to define. In general when rehydrated the product should resemble the fresh vegetable as closely as possible as regards taste and texture and there should not be any off-flavours. These qualities are influenced by the vegetable variety, soil and climatic conditions, fertilization and irrigation of the crop and the method of processing. Storage conditions are also important for products which have to be stored for any length of time.

b. Colour

Colour should be characteristic of the vegetable, according to specification; for example green, white or cream (yellow) asparagus powder may be specified or green, white or green and white leek. Carrots should be a bright orange-red in colour so varieties which have a light-coloured core are unsuitable for dehydration (freeze-dried carrots tend to lose their colour quickly). Tomato powder and flake should be a rich red colour with no trace of browning or caramelization. Cauliflower florets should be white and free from browning. Dehydrated onions should be white or light yellow in colour and not red or brown.

c. Cut

Major users and importers have their own specifications for cut. There is some conflict so far as soup manufacturers are concerned between reducing the cooking time, thus specifying thinner or smaller cuts and improving the visual quality of the soup, which calls for larger pieces of vegetable. A commonly specified thickness for root vegetables is 2mm.

Major users have strict specifications for tolerated variation in size of cut, in particular the amount of powder and broken pieces when large pieces were specified. Slack packing of cartons and drums and careless handling of packages (especially paper sacks) can result in considerable breakage of fragile pieces of dehydrated vegetable.

In respect of French beans some buyers specify a maximum seed content of 10 per cent by weight.

d. Rehydration time

This is of most importance to soup manufacturers, "Five-minute Simmer" soups were introduced on to the United Kingdom market in 1968 and gave rise to an increasing demand for vegetables which would rehydrate quickly. This may be achieved in several ways – by using very small dice or very thin cuts with the maximum surface area, by drying the vegetables more quickly or using the newer puffing and freeze-drying techniques and certain soup manufacturers use citric acid to "tenderize" dehydrated vegetables and improve rehydration. Soup manufacturers in the United Kingdom now require dehydrated vegetables which will rehydrate in 5 minutes or less in a thick soup (not in water).

Rapid rehydration is of less importance to Continental soup manufacturers who generally require a rehydration time of about 10 minutes. Caterers and manufacturers of ready meals usually specify a rehydration time of about 15 minutes.

e. Freedom from foreign matter

As a rule importers specify complete freedom from foreign matter but in practice this is difficult to achieve unless electronic sorters are used. Many principal users employ a hand-picking or electronic sorting operation to remove foreign bodies such as pieces of glass, metal, wood or paper, small stones, insects, thread, brush bristles, hair etc as well as sand or soil, pieces of other dehydrated vegetables or pieces of burnt or damaged vegetables and tomato seeds in tomato flakes. Some buyers will pay a premium for guaranteed "clean" consignments in view of the cost of resorting. Strict attention to factory organisation and cleanliness should reduce the presence of foreign matter to a minimum, although certain vegetables (eg leeks and cabbages are more liable than others to contain sand and soil on account of their structure.

f. Moisture content

The level to which vegetables should be dried to produce the best possible product varies with different vegetables and the method of processing used. Maintenance of the optimal moisture content is fundamental to palatability and nutritive values and in cases of prolonged storage or for vegetable powders (which tend to be very hygroscopic) special precautions such as the use of in-container desiccants (where these are permitted) or special packing may have to be taken. Freeze-dried vegetables are generally dried to a moisture content between 2 and 3 per cent whereas air-dried vegetables are not usually dried below 4 per cent because of the risk of burning the vegetables. In fact specifications for diced or sliced vegetables usually call for about 6 per cent moisture content, and those for powders 4 to 5 per cent. However, a higher moisture content, of up to 10 per cent may be specified for capsicum flakes and peas.

g. Bacterial count

When most dehydrated vegetables, or products made from them, were cooked in boiling water for ten minutes or more, the hazard to the consumer from bacteria was small; however, the advent of 5 minutes simmer soups has influenced some users to pay closer attention to this factor. At present there are no European standards or legal limits regarding the bacterial count of dehydrated vegetables, but it is expected that a maximum permissible count of 300,000 per gram may be agreed by some countries in the near future (this level is already enforced in Sweden, for example). Some users do include maximum bacterial levels in their specifications and these are generally of the order of 100,000 per gram, although the requirements of baby food manufacturers are much more stringent — only 5,000 per gram. *Salmonellae* must be entirely absent and requirements concerning *B.coli* and yeasts and moulds usually specify upper limits of 10 and 300 per gram respectively.

Some of the leading soup manufacturers have observed that this factor of bacterial contamination seems to pose problems for developing countries. The raw vegetables must be kept clean, then the processing must be carried out under sterile conditions and finally the dehydrated vegetables must be packed so as to avoid any contamination. Various methods are used in industrialised countries to minimise the presence of bacteria — in the United States one onion processor washes the raw onions in water containing a very high chlorine concentration to reduce the bacteria level, dehydration is carried out entirely in stainless-steel equipment which is easy to clean and packing is done by automatic machinery. A processor in the Netherlands insists that a very high standard of personal cleanliness is observed by his staff and that all employees in the dehydration plant have a bath at the factory once a week. Continuous testing of samples in well-equipped laboratories ensure that standards are maintained.

h. Permitted additives

Vegetables may be sulphited after blanching in order to prevent browning reactions spoiling the appearance, particularly of white vegetables such as potatoes, celeriac and cauliflower. Other coloured vegetables may also be sulphited for although the SO₂ has a bleaching action some loss of colour (which depends on the concentration of the sulphiting agent) is preferable to allowing the browning reactions to develop. However, SO₂ residues are completely forbidden in Germany and may soon be banned in France and Scandinavia. There are no statutory limits in the Netherlands, although the soup manufacturers have their own specifications. The legal limits of SO₂ residue for the United Kingdom are laid down in the 1962 Statutory Instrument No 1532 and are as follows:-

Potatoes	SO ₂ residue not to exceed	550 ppm
Cabbage	SO ₂ residue not to exceed	2,500 ppm
Other vegetables	SO ₂ residue not to exceed	2,000 ppm

In fact the specifications of the soup manufacturers in the United Kingdom generally provide for rather lower limits, ranging from 500 to 1,500 ppm according to type of vegetable and manufacturers of baby foods require a nil residue.

j. Trace elements

Legal standards in respect of lead and arsenic are specified in the United Kingdom Statutory Instruments as follows:-

Lead	1961, SI 1931	shall not exceed 2 ppm (parts per million)
Arsenic	1959, SI 831, 928 (S.51) 1960, SI 2261, 2344 (S.126)	shall not exceed 1 ppm

k. Reaction to peroxidase and catalase tests

Where these tests are relevant most users specify negative reactions. Most vegetables are blanched during processing in order to destroy the natural enzymes, and if this is done correctly the vegetables will have a negative reaction to the peroxidase and catalase tests. Vegetables whose flavour depends on enzymatic action eg onions, garlic, sweet peppers and leek are not blanched and the tests are therefore irrelevant.

PACKING AND STORAGE

Dehydrated vegetables are packed in both air-tight and non-airtight containers (the type of packing used affects the duty payable on some vegetables imported into the United Kingdom). Ideally all dehydrated vegetables should be packed in hermetically sealed cans or drums of tin-plate, since oxidative changes lower the quality of the vegetables and the exclusion of air is therefore fundamental to the maintenance of quality. However this method of packing is very expensive and its use has declined, although it is still used for the more expensive products, for powders (which are very hygroscopic), when shipping to or from tropical areas or when gas-packing with nitrogen is necessary (see below).

The use of polyethylene as a packing material has increased in recent years since it is relatively cheap and moisture-proof; it is generally used in conjunction with fibreboard cartons and drums, cardboard cartons or multiwall paper sacks. Polyethylene liners may be heat-sealed to give an air-tight closure, however there is a certain amount of diffusion of air through the polyethylene.

Although vacuum-packing is not a technique generally used in the packaging of dehydrated vegetables, it has certain advantages, notably the preservation of quality of the product and the compression of the pieces of dehydrated vegetables into a smaller volume (which may permit savings in freight costs).

It should be noted that containers which are suited to palletization are gaining in popularity since this reduces handling costs and damage to the produce. For this purpose cartons are much more suitable than paper sacks or even drums (which are wasteful of freight space).

For many manufacturers the size of the package is immaterial because their consumption is so large that the entire contents of a pack are used at one time. Common sizes of packs are 12 Kg, 25 Kg, 40 Kg and 100 Kg. Caterers require smaller packages, usually of a half to 3 kilos in weight; however it is usual for dehydrated vegetables to be imported in bulk, and repacked if necessary for the catering trade.

An inert gas, usually nitrogen, is used for packing certain vegetables, especially those which are particularly subject to oxidative changes e.g. carrots. Some users may specify gas packing for certain vegetables.

Ideally, dehydrated vegetables should be stored under controlled conditions of temperature and humidity. One major European user stores dehydrated vegetables at a temperature of 17-18°C and 35 per cent relative humidity. Some users in the United Kingdom specify the maximum temperatures at which vegetables should be stored, ranging from 2°C to 12°C for most products, but as high as 21°C for onions. In general, if dehydrated vegetables have to be stored for any length of time under tropical conditions they should be packed in hermetically-sealed containers.

PHYTO-SANITARY REGULATIONS

Phyto-sanitary certificates are not required for dehydrated vegetables imported into the United Kingdom, the Netherlands, Belgium, France or Italy, although the last-named country prohibits imports of beetroot on phyto-sanitary grounds. However, all imports are liable to inspection by officers of the Plant Health and Public Health authorities and any evidence of e.g. insect infestation may result in a consignment being impounded or destroyed.

QUOTA AND TARIFF RESTRICTIONS ON TRADE

Restrictions on trade in dehydrated vegetables vary from country to country, even within the EEC. The United Kingdom controls trade only with Eastern Bloc countries, by annually negotiated quotas; however, the quotas have not been very restrictive at least so far as East European countries are concerned. The Netherlands and Belgium require import licences for imports from East Europe, although these are freely available. On the other hand France permits imports from countries outside the EEC only under licence against a quota which is fixed each year by the French Government. Licences are difficult to obtain, especially for imports of onions, garlic, tomatoes and champignon mushrooms. These are special quota agreements for imports from Morocco (a former French protectorate) and Israel.

United Kingdom import duties on dehydrated vegetables are lower than the common external tariff (CET) of the EEC countries at present (except for peas); however, if the United Kingdom becomes a member of the EEC her tariffs will have to be aligned with the CET five years after first joining the Community i.e. probably by 1978.

			General Tariff	Exceptions
United Kingdom				
07.04	Garlic and capsicums	free	—	
	Tomatoes and leeks	10% ad valorem	Commonwealth countries, EFTA countries, South Africa and Irish Republic - free	
	Asparagus	10% ad valorem	Commonwealth, South Africa and Irish Republic - free	
	Other Vegetables in air-tight containers	15% ad valorem	Commonwealth, South Africa and Irish Republic - free	
	in non air-tight "	10% ad valorem		
07.05	Dried Green Peas	£0.375 per cwt (112 lb) or 10% ad valorem, whichever is the greater	Commonwealth, South Africa and Irish Republic - free	
European Economic Community				
07.04	Onion	18% ad valorem	Associated territories	
	Other Vegetables	16% ad valorem	Associated territories	
07.05	Peas	4.5% ad valorem	Associated territories	

The distinction drawn in the United Kingdom tariff between imports packed in air-tight and non air-tight containers appears to stem from a historical accident and no longer applies to dehydrated tomatoes, garlic, capsicum, leeks and asparagus. The effect of the higher duty on air-tight packages has been to discourage the use of this type of pack (e.g. for custom purposes a heat-sealed polyethylene bag is air-tight, whereas a bag tied at the neck is not).

Both the United Kingdom and the EEC grant tariff preferences to a number of countries. In the case of the United Kingdom, Kenya is virtually the only Commonwealth country which exports dehydrated vegetables, and thus benefits from tariff preferences; Portugal and Switzerland (both members of EFTA) benefit from free entry for tomatoes and leeks but the Irish Republic is the supplier which has benefited most from tariff preferences. In the EEC imports from other member countries enter duty-free, as do imports from territories associated with the EEC.

If the United Kingdom enters the EEC, many Commonwealth countries are likely to obtain some form of association, while Portugal, Sweden and Switzerland are trying to negotiate special trade agreements with the EEC. The Irish Republic, Norway and Denmark besides the United Kingdom are seeking full membership of the EEC.

At present the United Kingdom does not levy internal taxes on foodstuffs; it remains to be seen whether or not the value-added tax, to be introduced in 1973, will be applied to foodstuffs and if so at what level. If it is applied the same level of tax is likely to be levied on all foodstuffs, so the competitive position of dehydrated vegetables vis-a-vis fresh and other processed vegetables should not be affected greatly.

The EEC countries already levy value-added taxes on foodstuffs. The rates of tax levied on dehydrated vegetables are as follows:-

Netherlands:	Onions, sliced or cut	4% ad valorem
	Other vegetables and powdered onions	14% ad valorem
Belgium:	All dehydrated vegetables	6% ad valorem
Luxembourg:	All dehydrated vegetables	10% ad valorem
France:	All dehydrated vegetables	7.5% ad valorem
Italy:	All dehydrated vegetables	5.5% ad valorem

IMPORT MARKETS

United Kingdom

Domestic Production

There are only two substantial producers of dehydrated vegetables in the United Kingdom and no statistics of production are available. One of the two manufacturers, Batchelor's Foods Ltd., produces large quantities of dehydrated peas and smaller quantities of beans for sale as catering vegetables in retail and bulk packs and also for use in their soups and ready-meals. This firm also dehydrates small quantities of cabbage for use in soups. The second firm, Swel Foods (formerly FMS (Produce) Ltd) dehydrates a wider range of vegetables — peas, carrots, swede, savoy cabbage, beetroot, potatoes and in some seasons, beans. These vegetables are sold to other food manufacturers and also in catering and retail packs of vegetables and in catering soups sold under the 'Swel' brand.

Although it is not possible to estimate the tonnage of dehydrated vegetables produced in the United Kingdom with any accuracy, possibly it amounts to as much as 2,000 tons per annum, peas being the most important product, followed by carrots, beans, swede, potatoes, cabbage and beetroot. There are no producers of freeze-dried vegetables in the United Kingdom.

Imports

a. Total import demand

The United Kingdom is the world's major importer of dehydrated vegetables. The quantities imported during the years 1960 to 1970, as shown in the Trade Returns, are summarised in Table 5.

Unfortunately dehydrated vegetables (other than onions) packed in airtight containers were included in composite categories with various canned vegetable products prior to 1963. Also, it seems very likely that imports from Canada during the period 1963 to 1967 included substantial quantities of "instant" potato flake and powder. Thus some adjustment has to be made to the "raw" trade data. Table 6, shows estimated total imports of dehydrated vegetables for the years 1960 to 1970; imports of unspecified types of vegetable from Canada have been excluded for the years 1963 to 1967 while estimates of imports of dehydrated vegetables in airtight containers for the years 1960 to 1962 have

Table 5
**United Kingdom Imports of Dehydrated Vegetables 1960 to 1970 as shown
in the Trade Returns**

		Onions in Air-tight Containers (a)	Others in Air-tight Containers	Others in non Air-tight Containers (b)	TOTALS
1960	tons £'000	841 115.4	...	4,008 657.3	4,849 772.7
1961	tons £'000	765 126.0	...	3,370 835.8	4,135 961.8
1962	tons £'000	1,009 224.0	...	6,463 1,945.5	7,472 2,169.5
1963	tons £'000	1,399 347.2	1,322 531.2	5,849 2,085.8	8,570 2,964.2
1964	tons £'000	838 204.6	1,009 526.1	5,156 1,733.0	7,003 2,463.7
1965	tons £'000	1,416 297.9	1,205 633.7	5,759 1,817.4	8,380 2,749.0
1966	tons £'000	1,405 280.8	1,723 717.5	6,714 2,125.4	9,842 3,123.7
1967	tons £'000	1,702 331.5	1,295 544.8	8,652 2,744.7	11,649 3,621.0
1968	tons £'000	4,725 1,165.7	...	5,909 2,639.8	10,634 3,805.5
1969	tons £'000	6,150 1,738.3	...	6,396 3,026.4	12,547 4,764.7
1970	tons £'000	7,895 2,795.2	...	7,679 3,673.4	15,574 6,368.6

Source *The Trade of the United Kingdom*
HM Customs and Excise

(a) Includes onions in non air-tight containers from 1968

(b) Includes others in air-tight containers from 1968.

been made on the assumption that these accounted for the same percentage of the total in 1960-62 as in the years 1963-67 (about 15 per cent).

In addition to the vegetables shown under the SITC trade category 0550, dehydrated peas are imported, chiefly from the Irish Republic, under SITC category 05409: "Dried shelled peas (including peas for sowing) whole, green or blue". Since the Irish Republic does not produce dried marrowfat peas to any extent, imports from this source under category 05409 may be assumed to be almost entirely of dehydrated peas (this hypothesis is supported by their high cif value) — the quantities involved are also shown in Table 6.

On the basis of the data in Table 6 United Kingdom imports of dehydrated vegetables other than peas increased by 120 per cent between 1960 and 1969 from 5,705 tons to 12,547 tons valued at £4.76 million (\$11.4 million). There was a further substantial increase in imports in 1970, amounting to 23 per cent of 1969 imports. Imports in 1970 were valued at £6.37 million (\$15.3 million). Imports of dehydrated peas from the Irish Republic rose from only 2 tons in 1960 to 1,110 tons in 1969.

b. Types of vegetables imported

Before 1968 — see Table 6 — the trade category "dehydrated vegetables packed in non air-tight containers" included large quantities of onions, particularly kibbled onions, imports of potatoes and probably also small quantities of tomatoes, asparagus and beans. Thus it is impossible to estimate the relative importance of the various types of vegetables imported

Table 6
United Kingdom Imports of Dehydrated Vegetables 1960 to 1970 (estimated)

Year	In non-air-tight containers		In air-tight containers		TOTALS (1) to (7)		Peas
	Unspecified (1)	Onions (2)	Tomatoes (3)	Asparagus (4)	Unspecified (6)	Potatoes (7)	
1960	tons £'000	4,008 657.3	841 115.4	(a)	(a)	(b)	(5,705) ...
1961	tons £'000	3,370 835.8	765 126.0	(a)	(a)	(b)	(4,865) ...
1962	tons £'000	6,463 1,945.5	1,009 224.0	(a)	(a)	(b)	(8,791) ...
1963	tons £'000	(5,799) (2,072.3)	1,399 347.2	600 175.3	52 32.0	(b)	(8,472) (2,944.0) ...
1964	tons £'000	(4,854) (1,698.7)	838 204.6	350 156.4	97 44.5	(b)	(6,661) (2,422.1) ...
1965	tons £'000	(5,612) (1,789.7)	1,416 297.9	128 148.9	129 51.1	(b)	(8,181) (2,709.1) ...
1966	tons £'000	(6,286) (2,051.3)	1,405 280.8	420 205.6	49 32.3	(b)	(8,835) (2,939.3) ...
1967	tons £'000	(8,091) (2,633.4)	1,702 331.5	479 231.5	105 72.5	(b)	(10,671) (3,423.3) ...
							In all types of container
1968	tons £'000	3,947 1,870.1	4,725 1,165.7	1,068 610.0	(c)	(c)	894 159.7
1969	tons £'000	4,112 2,270.9	6,150 1,738.3	979 541.0	(c)	(c)	1,306 214.5
1970	tons £'000	4,778 2,613.9	7,895 2,795.2	1,145 629.4	(c)	(c)	1,756 1,020 12,547 4,764.7 15,574 6,368.6 ...
							10,634 3,805.5

Source *The Trade of the United Kingdom*
HM Customs and Excise

Not available Included in column 6
 ... Included in columns 1
 (a) Included in column 1
 (b) TPI estimate
 (c) ()

Not available

Included in co

Included in co

c) Included in co-

TP| estimate

for the years 1960 to 1967. The percentages of total imports of dehydrated vegetables (excluding leguminous vegetables) imported in 1968, 1969 and 1970 were as follows.

	Onions	Tomatoes	Potatoes	Garlic & Leeks	Others
1968	44	10	8	(a)	38
1969	49	8	10	(a)	33
1970	51	7	13	3	26

Note:- (a) = included with "Others"

The above table demonstrates the importance of dehydrated onions in total imports, and the fact that onion imports increased in relative importance over the three years 1968 to 1970.

The "other vegetables" category is quite a large one – information supplied by several foodstuffs manufacturers suggests that the most important vegetables imported under this heading are carrots, cabbage, green beans, parsnips, (in 1968 and 1969) leek, mushrooms, asparagus, swede and celeriac. Garlic, shown with leeks in a separate category in 1970, is probably also of some importance (1970 imports were estimated at about 150 tons). This category also includes imports of horseradish and herbs which were shown separately in 1970 and amounted to 2.4 per cent of "other vegetable" imports.

c. Sources of supply

Table 7 lists the leading suppliers of dehydrated vegetables to the United Kingdom over the period 1965 to 1969, in order of the quantities supplied. The first five countries listed together supplied 58 per cent, and the first ten countries supplied 86 per cent of the total over this period.

The proportion of the total tonnage supplied by each country in 1969 is shown in the final column. Egypt, as the major supplier of onions, the most important type of vegetable imported, has consistently been the most important supplier to this market in tonnage terms, and Hungary, another important source of onions (along with other types of vegetables) also figures among the first five suppliers. However the Netherlands supplies only minor quantities of onions (mainly re-exports in recent years) and the Irish Republic, whose share of the market increased very rapidly over the period (although imports from this source were unusually low in 1965) supplies only very small quantities of onions, almost certainly re-exports. The United States supplies a very wide range of dehydrated vegetables, including a proportion of onions. It will be noticed that imports from Israel and Italy have declined, while imports from the Lebanon (chiefly onions) and Morocco (tomatoes) have increased.

d. Imports of onions

It was explained in Section b that total imports of onions cannot be estimated prior to 1968, but in 1968 onwards onions comprised 44 per cent or more of total imports of dehydrated vegetables. Imports rose from 4,725 tons valued at £1.17 million (\$2.8 million) in 1968 to 6,150 tons valued at £1.74 million (\$4.2 million) in 1969 and to 7,895 tons in 1970 – an increase of 67 per cent over two years. Imports of dehydrated onions in airtight containers (assumed to be mostly onion powder) rose from 841 tons in 1960 to 1,702 tons in 1967, an increase of 102 per cent. Imports in airtight containers amounted to 1,184 tons in 1970; however sizeable quantities of US onion powder were imported in non-airtight containers in that year.

Egypt was the major supplier throughout the period 1960 to 1969, supplying 38 per cent of the total in 1968 and 34.5 per cent in 1969. Hungary was the second most important supplier, accounting for 18 and 14 per cent in these years respectively, followed by Bulgaria and Roumania. Moreover imports from Germany,

Table 7
Imports of Dehydrated Vegetables into the United Kingdom by country of origin

		1965 (a)	1966 (a)	1967	1968	1969	Share of total imports in 1969
TOTALS	tons £'000	8,181 2,709.1	8,835 2,939.3	10,671 3,423.3	10,634 3,805.5	12,547 4,764.7	
of which from:-							
UAR Egypt	tons £'000	1,822 390.0	1,847 419.5	1,621 364.1	1,938 463.7	2,188 589.6	17.4
Hungary	tons £'000	877 249.4	809 230.3	1,095 302.4	1,403 409.0	1,402 474.3	11.1
Netherlands	tons £'000	1,156 476.2	838 370.8	956 393.0	994 535.7	1,173 537.0	9.3
Irish Republic	tons £'000	123 106.8	791 207.7	883 278.1	1,280 377.8	1,947 852.4	15.5
Israel	tons £'000	1,260 262.4	1,055 265.3	874 238.3	595 226.8	673 242.8	5.4
Bulgaria	tons £'000	563 123.0	723 176.1	1,611 387.6	746 170.6	583 172.5	4.6
United States	tons £'000	685 285.5	671 294.5	1,085 390.1	764 285.7	874 362.9	7.0
Morocco	tons £'000	209 93.3	368 170.4	480 228.3	552 295.1	642 344.4	5.1
Lebanon	tons £'000	174 86.9	257 89.9	443 114.4	211 58.4	665 197.1	5.3
Roumania	tons £'000	143 41.2	308 88.5	501 125.7	326 80.6	397 105.3	3.2
Italy	tons £'000	449 184.4	484 204.6	236 122.5	170 104.0	104 77.6	0.8
German Fed Rep	tons £'000	69 52.3	118 103.0	142 101.8	342 134.0	563 178.8	4.5
Portugal	tons £'000	6 3.5	31 21.6	85 50.7	395 242.9	326 199.3	2.6
Kenya	tons £'000	104 32.9	70 24.2	113 35.1	283 80.7	121 33.8	1.0
Other Countries	tons £'000	541 321.3	465 272.9	546 291.2	635 340.5	889 396.9	7.1

Source *The Trade of the United Kingdom*

(a) amended figures (see text)

Switzerland and the Netherlands are almost certainly re-exports from East European countries, so produce of East European origin accounted for some 43 per cent of the total in 1968 and 38 per cent in 1969. The only other suppliers of importance are the United States and the Lebanon which contributed respectively 11 per cent and 4 per cent of the total in 1968 and 13 per cent and 11 per cent in 1969. It is interesting to note the recent entry of Sudan as a supplier of dehydrated onions to this market; this country accounted for 3.5 per cent of total supplies in 1969.

Although Israel was quite an important supplier of dehydrated onions in earlier years, accounting for 15 per cent of imports in airtight containers in 1965, in recent years supplies from this source have declined to negligible proportions.

In spite of the rise in imports in 1970, demand exceeded supply for a large part of the year and imports from the United States rose to 29 per cent of the total, as against 24 per cent from Egypt, 14 per cent from Bulgaria, 8 per cent from Hungary and 6 per cent each from Lebanon and the Netherlands. However, 1970 was an unusual year with reduced crops in Europe and the Middle East.

e. Imports of tomatoes

Total imports of dehydrated tomatoes were not shown separately in the Trade Returns prior to 1968, however in contrast to onions, a large proportion of dehydrated tomatoes imported are packed in airtight containers owing to the hygroscopic nature of tomato powder. Imports of tomato flake are of relatively little importance, the bulk (estimated at over 80 per cent) being of tomato powder. Total imports amounted to 1,068 tons valued at £610,000 (\$1,460,000) in 1968, declined slightly to 979 tons valued at £541,000 (\$1,30 million) in 1969 but rose again to 1,145 tons in 1970. Previously imports of tomatoes packed in airtight containers were as high as 600 tons in 1963 and fell to 302 tons in 1965 before rising again to 479 tons in 1967.

In 1963 when statistics first became available for tomatoes in airtight packs Bulgaria was the major supplier, accounting for 39 per cent of the known market, but did not supply this market in later years. Italy supplied 28 per cent of the known market in 1963 and 50 per cent in 1964, but her share of the total market has since declined to 2 per cent in 1969. Morocco supplied 23 per cent of the known market in 1963 and since 1965 has been the major supplier, accounting for 63 per cent of supplies in 1969. In recent years Portugal has become the second most important supplier, providing 33 per cent of the total in 1968 and 30 per cent in 1969. Morocco and Portugal together supplied 84 per cent of the total in 1968, 93 per cent in 1969 and 90 per cent in 1970. Minor suppliers include the Netherlands and Switzerland — in both these countries dehydrated tomato powder is manufactured from imported puree. In earlier years (before 1966) France also supplied small quantities — as much as 14.5 per cent of the known market in 1965, possibly including re-exports from Morocco.

f. Imports of potatoes

Cut, diced and powdered dehydrated potatoes have been shown in a separate category only since 1968. Imports in that year totalled 894 tons valued at £159,700 (\$383,300) and rose in 1969 to 1,306 tons, valued at £214,500 (\$514,800). In 1970 there was a further rise to 1,763 tons, which represents a 97 per cent increase over the 1968 figure.

The major supplier is the Irish Republic which supplied 54 per cent of the total in 1968 and 42 per cent in 1969. The second most important supplier is Germany (20 per cent and 33 per cent respectively in 1968 and 1969) followed by Israel (9 per cent and 15 per cent respectively); other suppliers were the Netherlands, the United States and Canada. In 1970 the market shares were as follows: Irish Republic 57 per cent, Germany 16 per cent, Netherlands 12 per cent and Israel 7 per cent.

g. Imports of other vegetables

As has already been explained the categories used by Customs prior to 1968 were such that there was no vegetable for which the total imports were known. This implies, of course, that neither are the total imports of "other vegetables" known before that year. In 1968 imports of other vegetables, whether in airtight or non-airtight containers were shown in a single category and in that year imports amounted to 3,947 tons valued at £1,870,100 (\$4.49 million). In 1969 imports rose to 4,112 tons valued at £2,270,900 (\$5.45 million) and the figures for 1970 (including garlic and leeks, horseradish and herbs, in fact shown separately for the first time) show a further increase in tonnage to 4,778 tons valued at £2,613,900 (\$6.27 million). This represents a 22 per cent increase over two years.

The Irish Republic and the Netherlands are the major suppliers of these vegetables, each accounting for 19 per cent of total imports in 1968, although the Irish Republic's share of the market rose to 33 per cent in 1969 and 34 per cent in 1970, while the Netherlands' share fell to 15 per cent in 1969 and to 11 per cent in 1970. (It should be noted that imports from the Irish Republic enjoy duty-free access to the United Kingdom market.) As was noted in section (c) both these countries

supply a wide range of dehydrated vegetables. Hungary and Israel are also important suppliers, the former accounted for 14 per cent of the total supplies in both 1968 and 1969 while Israel supplied 12 per cent in 1968 and 11 per cent in 1969. Hungary supplies most root and green vegetables, and also peppers and Israeli producers specialise in carrots, peppers, leeks and beetroot. Of the other suppliers, imports from Kenya are chiefly carrots, but also include leeks and cabbage, and Bulgaria is an important supplier of *B. edulis* mushrooms while France supplies asparagus and champignon mushrooms. Imports from Germany are assumed to be largely re-exports of Portuguese and East European produce. Egyptian exports are almost entirely garlic and leeks.

Exports and Re-Exports

No statistics of domestic exports of dehydrated vegetables are available because before 1970 exports of dehydrated vegetables were included with other vegetable products in a composite category in the Trade Returns.

Before 1970 trade statistics of re-exports were available for the same categories as the import statistics. Re-exports during the period 1960 to 1969 are shown in Table 8 below:-

Table 8
Re-Exports of Dehydrated Vegetables from the United Kingdom
(Metric Tons)

	In Non-Airtight containers Unspecified (1)	In Airtight Containers				TOTALS (6)
		Onions (2)	Tomatoes (3)	Others (4)	Potatoes (5)	
1960	76	79	...	...	...	...
1961	36	58	...	...	...	...
1962	72	70	...	...	...	...
1963	103	64	4	43	(a)	214
1964	30	58	1	17	(a)	106
1965	58	56	3	19	(a)	136
1966	90	94	1	13	(a)	198
1967	175	53	10	19	(a)	257
In all types of Container						
1968	109	160	6	...	15	290
1969	131	89	27	...	10	257

Source: *The Trade of the United Kingdom*
HMSO ... Not available
(a) Included in columns 1 and 4

It is evident that re-exports of dehydrated vegetables were of a very minor importance, representing only 3 per cent of total imports in 1968 and 2 per cent in 1969. Onions were, not unexpectedly, the most important type of vegetable re-exported.

Since January 1970 exports and re-exports have been shown in a combined category in the Trade Returns including all dehydrated vegetables. In 1970 United Kingdom exports and re-exports were 1,030 tons valued at £380,600 (\$ 913,400) in that year. In view of the world shortage of dehydrated onions in 1970 it is possible that re-exports were higher than in previous years. Thus no conclusions can be drawn as to the probable level of domestic exports in earlier years.

Unfortunately, it is not possible to estimate domestic exports or re-exports of dehydrated peas, which are probably the most important dehydrated vegetable exported from the United Kingdom.

Net Demand for Dehydrated Vegetables

It will be evident from earlier sections that it is very difficult to estimate United Kingdom demand for dehydrated vegetables owing to lack of information about domestic production, although net demand for certain types of vegetables which have to be imported may be estimated (e.g. onions and tomatoes).

Table 9 below is derived from Tables 6 and 8, and from information supplied by the trade; it shows net demand for three specified vegetables, together with annual totals (excluding peas) for the years to 1970. While the figures for the specified vegetables give a good idea of net demand the totals are less reliable since they should be larger by the amount of domestic production, less exports in 1968 and 1969.

Table 9
Estimated Net Demand for Dehydrated Vegetables in the United Kingdom
(Tons)

	1968	1969	1970
TOTALS	10,344+	12,290+	14,544+
Onions	4,565	6,061	7,895-
Tomatoes	1,062	952	1,145-
Garlic	...	...	150

Sources: *The Trade of the United Kingdom and trade information*.

Structure of the Trade

The structure of the United Kingdom trade in dehydrated vegetables is rather complex in that while principally a raw material for various types of foodstuffs, dehydrated vegetables are also sold for "direct" consumption as culinary vegetables. Nevertheless from the point of view of the overseas producer the trade can be divided into two sectors — the dried soup manufacturers and other major users who buy their supplies directly from producers of dehydrated vegetables, and users who buy from importers and agents. These sectors may be labelled "direct-buying" and "traditional". However it should be noted that the direct buyers still rely to some extent on purchases from the "traditional" sector to top-up supplies.

TRADITIONAL

a. Agents

A number of overseas producers of dehydrated vegetables sell on the United Kingdom market through sole agents — this applies to the two Israeli producers, the three major manufacturers of onions in the United States, one Dutch firm, the Kenyan processor and all Hungarian dehydrated vegetables.

The agencies may be held for the United Kingdom alone or for a group of European countries. Agents handle bulk orders from importers and major users of dehydrated vegetables, passing them back to the processor; they work on a commission basis.

b. Importers

There are a large number of importing firms which handle dehydrated vegetables, most of them being based in London. Dehydrated vegetables are usually handled as one of a number of raw materials for food manufacturers. Most importers act as agents for one or more overseas producers and also trade as principals and on their own account (i.e. buying outright). Some importers specialise in a few types of vegetables of which they hold stocks, while others handle a wide range of vegetables but generally buy on a hand-to-mouth basis. Since dehydrated

vegetables are subject to gluts and shortages, but may be stored for relatively long periods of time, importers may buy stocks on a speculative basis.

Importers sell to manufacturers, wholesalers and large institutional caterers, but not to small retail concerns.

c. Wholesalers

Wholesalers do not play a very important part in the dehydrated vegetable trade since much of the trade is concluded between importers and users. However, the requirements of some caterers and bakers are handled by wholesalers though they tend to handle the cheaper vegetables — onions, potatoes, carrots, peas, beans and cabbage — a proportion of which are domestically produced.

Grocery wholesalers naturally handle both retail packs of dehydrated culinary vegetables and food products containing dehydrated vegetables (soups, ready-meals etc); however these are obtained from food manufacturers.

DIRECT-BUYING

Most of the dried soup manufacturers buy the major part of their dehydrated vegetable requirements direct from the producers except where sole agencies are involved. These major buyers place contracts a season in advance to allow producers time to arrange their production programme. Soup manufacturers have very stringent specifications and once they have found suppliers who can meet their specifications and quality requirements they tend to establish close and continuing relationships with them.

On the other hand the major soup manufacturers are always looking for better and cheaper raw materials, so a new entrant to the trade has an opportunity to prove that he can meet the manufacturers' specifications though initially the latter will only be interested in sample lots.

Only one retail firm in the United Kingdom — a large supermarket chain — buys dehydrated culinary vegetables direct from the producer for sale under its own label; "Private-label" soups are all made by the major soup manufacturers.

Outlets

Dehydrated vegetables can be substituted for fresh vegetables in a great variety of food products, thus outlets for dehydrated vegetables are very numerous. The major advantage of dehydrated vegetables to the user, whether manufacturer, caterer or housewife, is their convenience in that the vegetables are ready for cooking and no trimming or peeling is necessary, also dehydrated vegetables have a long shelf-life. Against these advantages are the disadvantages that for certain uses the vegetables must be rehydrated before cooking and for certain vegetables cooking takes longer than for corresponding fresh or other processed vegetable (peas and beans, for instance).

The four types of outlet which need to be examined to determine trends in demand for dehydrated vegetables are dried soup manufacturers, other food manufacturers, the catering industry and the retail trade in dehydrated culinary vegetables. Each of these sectors is described in detail below.

a. Dried soups

Dehydrated soups are a relatively new product in the United Kingdom, in recent years they have however taken a considerable share of the soup market which is nevertheless still dominated by canned soups. This situation is the reverse of that in most Continental European countries where canned soups are the newer product.

Production of canned and dried soups in the United Kingdom over the period 1960 to 1970 is shown in the table below:-

Soup Production in the United Kingdom 1960-1970

Year	Canned Soups		Dried Soups	
	'000 tons (reconstituted basis)	Index 1960 = 100 (1)	'000 tons	Index 1960 = 100 (4)
1960	204.1	100	12.6	100
1961	217.7	107	14.6	116
1962	252.8	124	15.5	123
1963	287.6	141	18.2	144
1964	265.5	130	18.7	148
1965	290.3	142	20.0	159
1966	302.6	148	21.5	171
1967	269.8	132	21.0	167
1968	277.4	136	25.6	203
1969	290.5	142	27.4	218
1970	297.8	146	23.4	186

Sources: (1) *Ministry of Agriculture Fisheries and Food*
(2) *Food Manufacturers Federation*

The table shows that after a sharp increase in 1963 (due to a very cold winter) production of canned soups rose to a peak of just over 300,000 tons in 1966 — a 48 per cent increase over the 1960 figure; production then declined, before rising again almost to the 1966 peak in 1970. In contrast production of dried soups rose from 12,600 tons in 1960 to 21,500 tons in 1966, an increase of 71 per cent, and after a slight decline in 1967 the introduction of "five-minute-simmer" soups helped to stimulate consumption and production increased still further, to 27,400 tons in 1969 — an increase of 118 per cent over the 1960 figure. However, production declined in 1970.

According to expenditure figures in the Annual Report of the National Food Survey Committee dried soups accounted for 17 per cent of average household expenditure on soups in 1969 compared with 15 per cent in 1965. It is believed that dried soups have a larger share of the catering and institutional market which is increasing more rapidly than the retail market.

United Kingdom per caput consumption of soups is still at a relatively low level compared with that in most Continental European countries, (10) so there would seem to be scope for further expansion of demand and it is expected that dried soups will take an increasing share of the market.

It cannot be inferred that the trend of production of dried soup precisely reflects the trend of demand for dehydrated vegetables for use in dried soups since a large proportion of meat soups contain very minor quantities of dehydrated vegetables and no information is available concerning the market shares of the various types of dried soups.

There are three major producers of dried soups in the United Kingdom, all subsidiaries of major international companies. The market leader is Batchelor's Ltd (Unilever), followed by Knorr (Corn Products) and Maggi (Nestlé). Batchelor's is said to have more than half the retail market, whereas Maggi is the major brand in the catering and institutional field and Nestlé also manufactures dried soups for sale under private labels. Most of the three or four smaller manufacturers of dried soups concentrate wholly on the catering and institutional market.

The manufacturers of dried soups also market and in some cases produce, dehydrated culinary vegetables. Batchelor's are the brand leader in the retail market for dehydrated peas, beans and "cooking aids" while the other companies market culinary vegetables for the catering trade. Batchelor's and Knorr also manufacture dried ready-meals.

The relative importance of dried soup manufacture as an outlet for dehydrated vegetables has declined since 1960 according to trade reports, but there appears to have been little change between 1966/7 and 1970. Usage of dehydrated vegetables for dried soups amounted to approximately 3,300 tons in 1966/7 and to approximately 4,900 tons in 1970/1 (according to figures supplied by the firms concerned), representing respectively 34 per cent of average imports in 1966/7 and 32 per cent of imports in 1970. A much smaller proportion of dehydrated vegetable imports are thus used for dried soups in the United Kingdom than in any other European country.

b. Other food manufacturers

Dehydrated vegetables are now used in a wide range of food products as a substitute for fresh vegetables, especially by meat packers producing canned stews etc who may have no facilities for vegetable preparation. However, some major companies are able and prepared to switch from dehydrated to fresh vegetables according to their relative prices, so these firms' requirements vary from year to year. Nevertheless the convenience of using dehydrated vegetables and the fact that they are available all year round is encouraging more firms to substitute dehydrated for fresh vegetables, most especially in the case of onions, which are unpleasant to prepare.

One manufacturer of baby foods (Corn Products) uses dehydrated carrots and potatoes to permit the year-round production of canned baby-foods and there are also two ranges of dried baby foods. However, the specifications for dehydrates used in baby foods are very stringent, especially as regards bacterial limits.

One important outlet for dehydrated onions (and dried herbs) in the United Kingdom is the manufacture of "instant" stuffings for meat and poultry dishes. The market for stuffings has increased rapidly in recent years, since "broiler" chickens have been marketed at low prices. The market leader, Paxo, has manufactured a range of stuffings for many years and now also packs stuffings under private labels, while in the last few years a number of other brands have been introduced.

Onion powder and probably to a small extent tomato, garlic and mushroom powders are used in the manufacture of Saromex and Saroline — flavour compounds on respectively salt and rusk bases with a controlled bacterial count and consistent strength of flavour, which are widely used in foodstuffs manufacture. This would appear to be a growing market as manufacturers become more concerned about the bacteriological state of their raw materials.

Ready-meals, especially dehydrated ready-meals, have been seen as a potentially important outlet for dehydrated vegetables. Dried ready-meals were launched nationally by Batchelor's (Unilever) in 1962 and although various firms have entered this market since that time, Batchelor's still dominate the market and were estimated to have 85 per cent of the ready-meals market (dried and canned) in mid-1969 (6). The other two firms manufacturing dried ready-meals are Heinz and Knorr; both firms entered the market in 1969. Although production of ready-meals was increasing by up to 20 per cent per annum before 1968, it is not expected that the rate of growth will exceed 10 per cent per annum in future (7). Dehydrated vegetables are quite important ingredients in dried ready-meals but Batchelor's and Corn Products (Knorr) do not expect that usage of dehydrated vegetables for ready-meals will ever rival usage for dried soups.

c. Catering

Catering demand for dehydrated vegetables is a more important outlet in the United Kingdom than in any other European country. However, domestically-produced vegetables are possibly of more importance than imported. The most important outlets are institutions — industrial canteens, residential schools and colleges and hospitals (especially in cities and large towns). The armed forces are a relatively minor outlet since they use dehydrated foods only for special emergency food packs and in certain situations where space is at a premium e.g. submarines. School meals

services do not appear to be a very large outlet as yet. The demand from hoteliers and restaurateurs is small and confined mainly to establishments providing low-priced meals. Major catering firms and restaurant chains generally use fresh, frozen or canned vegetables in preference to dehydrated vegetables. Another type of outlet which could be included in this category are bakeries which use dehydrated vegetables for the production of meat pies etc.

Factors influencing demand for dehydrated culinary vegetables are the increasing difficulty and costs of obtaining labour for vegetable preparation, the price and quality of dehydrated vegetables compared with other forms of convenience vegetables and storage requirements for various types of vegetables in which respect dehydrated vegetables are the least demanding.

The catering demand for dehydrated vegetables reportedly increased rapidly between about 1965 and 1970 but the rise in demand now appears to be less rapid and the trade does not foresee a further acceleration in the rate of growth, unless the school meal services turn to dehydrated vegetables rather than the fresh, canned or frozen vegetables used at present. The major dried soup manufacturers all sell culinary vegetables to the catering trade but maintain that this is not a very profitable trade since competition is strong.

d. Retail trade

The United Kingdom appears to be the only European country with a significant market for dehydrated culinary vegetables at retail level. Batchelors (Unilever) are the brand leaders in this sector, having launched dehydrated peas (of their own manufacture), sliced onions and mixed vegetables in 1960, followed shortly by sliced French beans; in 1968 the range was further extended to include celery and sweet peppers. The other domestic processor of dehydrated vegetables, Swel Foods, has a small share of the market with peas, mixed vegetables and dried onions. Since 1968 a number of brands of sliced onions (all dehydrated onions are imported) have appeared on the market, but Batchelors still claim 50 per cent of the market. There is one private-label range of dehydrated vegetables (peas, beans and mixed vegetables) sold by a major supermarket chain and imported from the Irish Republic.

According to the National Food Survey, total household consumption of "air-dried vegetables" has been of the order of 2,500 to 3,000 tons per annum since 1966. Trade opinion suggests that consumption of culinary vegetables (peas, beans and mixed vegetables) has been declining slightly while consumption of "cooking aids" (onions, peppers etc) has risen strongly in recent years.

Terms of Trade and Margins

Dehydrated vegetables are invariably bought against sample and the major soup manufacturers at any rate will effect payment only once the products have been delivered and found to be in accordance with the contracted specifications. Most of the major buyers buy on cif terms, but many users now prefer to buy through importers on a "landed-duty-paid" (ldp) or "delivered" basis. Importers in the United Kingdom are generally opposed to issuing letters of credit.

Major users of dehydrated vegetables normally include a "buying-in" clause in their contracts which means that the supplier is responsible for meeting any extra costs; for example if the consignment is not up to sample and has to be resorted or returned.

The commission rate charged by agents is usually of the order of 5 per cent, the precise figure depending on the quantities handled and whether or not the agent is responsible for storage of the vegetables in the United Kingdom. The margin charged by importers when selling to manufacturers or wholesalers varies from 5 to 10 per cent, according to the quantity bought, larger quantities attracting a greater rate of discount.

Prices

The quality of dehydrated vegetables, the size and types of cut and users' specifications all vary considerably, this is reflected by a wide range of prices for vegetables of the same type though there is no source of regularly published prices. The only price data available over a period of years are the average annual cif values compiled from the official import statistics as shown in Table 10 below.

Table 10
Average Annual cif values of Dehydrated Vegetables imported into the United Kingdom
£ per m ton

Year	In non-airtight containers Unspecified	In air-tight containers				
		Onions	Tomatoes	Asparagus	Beans	Others
1960	164	137	...	...	...	...
1961	248	165	...	...	...	...
1962	301	222	...	...	...	...
1963	357	248	292	611	706	426
1964	350	244	444	458	808	529
1965	319	210	493	399	890	517
1966	326	200	490	654	904	515
1967	325	195	445	687	889	507
In all types of container						
1968	474	247	571	...	...	179
1969	552	283	553	...	...	164
1970	547	354	549	...	...	188

Source: *Derived from The Trade of the United Kingdom*

It may be seen that prices of onions and unspecified vegetables rose from 1960 to 1963 and then showed a downward trend to 1967; on the other hand the average import values of dehydrated tomatoes, asparagus and beans though erratic showed an upward trend from 1963 to 1967. Average values from 1968 onwards are not strictly comparable with those for earlier years, in the first place because no distinction was made as to type of packing and secondly because sterling was devalued by 14.3 per cent in late 1967 which had the effect of increasing the value of imports from countries which did not devalue their currencies at that time.

Since 1968 import values of onions have shown a marked upward trend, increasing by £71 per ton (\$170 per ton) between 1969 and 1970 in spite of a rapidly rising tonnage of imports into the United Kingdom. On the other hand import values of dehydrated tomatoes have declined somewhat since 1968.

In fact there was a more detailed break-down of imports in 1970 than that shown in Table 10; imports of horseradish, herbs, garlic and leeks were shown separately and imports of onions, potatoes and unspecified vegetables in airtight and non-airtight containers were differentiated, as shown below:—

Average Values of Dehydrated Vegetables Imported in 1970

	£ per ton
Horseradish	500
Herbs, not powdered	670
Tomatoes	549
Garlic and leeks	443
Onions in airtight containers	289
Onions in other containers	365
Potatoes in airtight containers	98
Potatoes in other containers	211
Other vegetables except asparagus in airtight containers	476
Other vegetables in other containers and asparagus	567

It may be assumed that dehydrated vegetables packed in airtight containers are mostly powdered. Thus, the values of onion and potato powders are considerably

lower than the values of kibbled onions and diced potatoes respectively despite the extra operation (grinding) required to produce them. This is because the non-powdered forms are required for their appearance as well as the flavour.

Prices for a number of dehydrated vegetables on a landed, duty-paid basis were obtained from United Kingdom importers in late 1970 and early 1971 as follows:-

Vegetable	Cut	Range of prices £ per ton, l.d.- p.
Onions	Kibbled or slices	496-606
	Powder	441-496
Potatoes	Diced	165-298
Tomato	Powder	606-1,102
Garlic	Powder	309-661
Leeks	Flake	474-827
Carrots	Diced or sliced	331-397
	Diced or sliced (puffed)	386-452
Asparagus	Tips	4,409-5,511
	Centre cut	2,756-3,307
	Powder	882-1,212
Beans	Sliced	496-827
	Cross cut	882
Beetroot	Diced and powder	353-386
Cabbage	Flake	551-661
Cauliflower	Florets	661-1,102
Celeriac	Flake	441-992
Mushrooms	<i>B.edulis</i>	4,409-5,511
	Champignon (air-dried)	3,307
Parsnips	Diced	551-661
Spinach	Flake	661
Sweet Peppers	Diced	882-1,543

Prices of dehydrated vegetables can change quite quickly in response to changing supply and demand factors. The prices quoted for dehydrated onions in the table above were very high owing to demand being strong when supplies were limited by crop failures and to a certain extent also to speculative pressures. However, early in 1971 the supply situation eased, importers who had bought larger quantities than they actually required in anticipation of prices remaining high began to unwind their positions and prices slumped, in some cases to only half of the prices quoted in the table. The prices of asparagus and *B.edulis* mushrooms were also historically high in late 1970, in the first case because of rising costs of production and in the second case because of a crop failure due to flooding in the main production areas.

Dried soup manufacturers in the United Kingdom are extremely cost-conscious and if the price of one vegetable rises they generally attempt to adjust their recipes. Thus the increased price of celeriac since devaluation has encouraged the use of parsnip as an alternative and the current high prices for peppers have led to the use of tomato flakes as a substitute garnish. The "flavour" vegetables (onions, tomatoes, mushrooms, asparagus, garlic) however have no natural substitutes and manufacturers seem unwilling to use synthetic flavours, even where these exist, with the possible exceptions of Saromex and Saroline onion flavours, both of which include dehydrated onion powder.

In view of the fact that EEC tariffs are higher than United Kingdom's, the entry of the United Kingdom into the EEC is likely to result in higher prices for some vegetables on this market particularly of dehydrated onions, although in view of their bargaining power, buyers in the United Kingdom may compel their suppliers to absorb a part of this tariff increase.

The Netherlands

Despite her relatively small population, the Netherlands is a major producer, exporter and importer of dehydrated vegetables. Many of the Dutch manufacturers of dried soups supply the Belgian market as well as the domestic market, which partly accounts for the apparently high consumption of dehydrated vegetables in

the Netherlands; also there is a significant re-export trade in dehydrated vegetables, notably onions, imported from Eastern European countries and re-sorted and re-packed in the Netherlands.

Domestic Production

The Netherlands' production of dehydrated vegetables, excluding potatoes and peas was estimated at 3,100 tons in 1968 and 1969 and at 3,200 tons in 1970 (8). Unfortunately separate data for dehydrated potatoes are not available. To judge from the export statistics however, production of dehydrated potatoes exceeds 3,000 tons per annum, thus making this vegetable the major type processed. There are three major producers of dehydrated vegetables in the Netherlands and a few minor processors, including two owned by soup manufacturers.

A very wide range of vegetables is dehydrated in the Netherlands, apart from potatoes the major products are carrots, celeriac (celery-root), beans, peas, leeks and cabbage. Onions were processed at one time but in recent years the cost of the raw material in the Netherlands has been too high to permit profitable production. There is some production of freeze-dried vegetables in about four plants in the Netherlands, the main types of vegetables processed being cauliflower, celery root, champignon mushrooms and leek.

Imports

a. Total import demand

The Netherlands is third in importance in terms of the tonnage imported among world importers of dehydrated vegetables, following the United Kingdom and Germany.

Imports for the years 1960 to 1970 are summarised in Table 11; they rose from 1,864 tons valued at £539,400 (\$ 1,510,000) in 1960 to 5,690 tons valued at £2,031,200 (\$ 4.87 million) in 1969 (an increase of 205 per cent) followed by a further rise to 6,721 tons in 1970; most of the increase has occurred in the years since 1964. In the period 1960 to 1964 imports increased by only 37 per cent, compared with a rise of 78 per cent in the period 1965 to 1969. The figures quoted above do not include imports of dehydrated peas, which are known to be imported from the Irish Republic and the United Kingdom in limited quantities.

b. Types of vegetables imported

Until 1970 dehydrated onion was the only vegetable shown in a separate import category in the Trade Returns — see Table 11, and in 1960 this vegetable was included with all other types. However estimates of imports of other types of vegetables are available from 1967 to 1969 and in 1970 another seven categories were introduced in the Trade Returns. In most years onions have comprised around half of the total imports. In 1970 the relative proportions of various vegetables imported were as follows:-

Onions	Tomatoes	Potatoes	Carrots	Leeks	Celery & Celeriac	Mushrooms	Beans	Per cent Others
46	16	11	10	6	2	1	neg.	8

The "others" category includes imports of garlic, asparagus, cauliflower, cabbage, spinach and herbs (parsley, mint etc).

Table 11
Dehydrated Vegetables imported into the Netherlands 1960-1970

	Onions	Tomatoes	Carrots	Leeks	Mushrooms	Beans	Potatoes	Others	TOTALS
1960	tons £'000	...	...	...	...	...	...	...	1,864 539.4
1961	tons £'000	914 172.9	...	...	...	...	...	...	1,414 439.4
1962	tons £'000	1,189 319.0	...	...	...	...	...	...	997 465.6
1963	tons £'000	901 233.4	...	...	...	...	...	...	1,424 623.6
1964	tons £'000	1,391 295.7	...	...	...	...	...	...	2,326 857.0
1965	tons £'000	1,827 359.0	...	...	...	...	...	...	1,160 2,551
1966	tons £'000	1,996 431.4	...	...	...	...	...	...	1,363 630.1
1967	tons £'000	2,045 428.7	(730) (342.7)	(418) (84.6)	(128) (36.9)	(44) (52.1)	(19) (13.6)	(32) (12.3)	794.8 499.1
1968	tons £'000	2,340 578.8	(949) (507.0)	(504) (116.7)	(228) (102.0)	(73) (94.0)	(29) (22.9)	(38) (17.4)	2,245 1,305.6
1969	tons £'000	2,789 750.6	(948) (497.9)	(454) (114.6)	(197) (79.7)	(67) (93.6)	(95) (64.7)	(44) (18.7)	4,241 (748)
1970	tons £'000	3,114 1,021.3	1,048 495.4	672 158.8	384 159.0	103 162.3	39 63.7	127 16.4	3,190 630.1
									989.1

... Not separately shown, included with "others"

Sources: *Maandstatistiek van de In-Uitvoer
Centraal Bureau voor de Statistiek*

() *Produktschap voor Groeten en Fruit*

c. Sources of supply

Table 12 lists the major suppliers of dehydrated vegetables to the Netherlands from 1965 to 1969. The major sources of imports are those countries which supply large quantities of onions and the other member-countries of the EEC — Germany, Italy and France.

Table 12
Imports of Dehydrated Vegetables into the Netherlands by country of origin

		1965	1966	1967	1968	1969	% in 1969
TOTALS of which from:-	tons £'000	3,190 989.1	4,241 1,305.6	4,208 1,302.7	4,687 1,700.4	5,690 2,031.2	
Germany	tons £'000	299 78.3	690 139.1	605 147.4	605 248.5	1,150 353.9	20.2
Hungary	tons £'000	288 80.2	288 56.4	687 149.1	902 225.5	1,073 296.6	18.9
UAR Egypt	tons £'000	537 103.6	588 120.3	530 115.4	541 130.6	651 168.1	9.9
Roumania	tons £'000	690 157.2	597 139.1	601 141.8	355 90.8	292 78.9	5.1
Italy	tons £'000	397 182.5	389 187.1	401 205.6	549 290.3	495 271.9	8.7
France	tons £'000	388 185.8	416 212.5	366 187.1	310 188.1	330 182.1	4.4
United States	tons £'000	89 63.3	129 105.2	210 96.2	191 78.2	336 136.8	5.9
Poland	tons £'000	80 13.0	160 29.2	74 12.0	50 9.0	163 40.1	2.9
Lebanon	tons £'000	11 2.8	82 18.9	87 19.0	95 22.5	167 44.7	2.9
China	tons £'000	7 2.4	86 41.2	108 34.0	116 29.9	107 41.5	1.9
Israel	tons £'000	12 3.6	53 16.3	78 27.3	122 41.1	122 52.2	2.1
Yugoslavia	tons £'000	30 9.7	97 28.2	81 22.4	141 52.1	29 11.1	0.5
Portugal	tons £'000	- -	9 4.4	29 14.2	132 65.8	110 65.2	1.9
Morocco	tons £'000	32 15.9	57 28.2	46 22.7	89 50.9	54 29.8	0.9
Other Countries	tons £'000	330 90.8	600 179.5	305 108.5	489 177.1	611 258.3	

Source: *Maandstatistiek van de In-Uit-Voer*
Central Bureau voor de Statistiek

The first five countries listed together supplied 64 per cent and the first ten countries 83 per cent (by weight) of total imports during the period 1965 to 1969. The proportion of the total tonnage supplied by each country in 1969 is shown in the final column.

The relative importance of the supplying countries changed considerably over the period 1965 to 1969. Germany and Hungary both increased their share of the market at the expense of Egypt and Roumania. Imports from Italy and France declined in importance while the United States, Lebanon, Israel and Portugal all increased their exports to this market. Germany, the main supplier in 1969 (and also in 1970), supplies a wide range of vegetables, in particular, large quantities of potatoes, carrots and onions (re-exports). Hungary, the major supplier in 1967 and 1968 exports large quantities of onions, also leeks and celeriac to this market. Egyptian supplies are almost entirely of onions, but include small quantities of leeks, while Roumania supplies leeks, carrots and mushrooms besides onions. Italy, France, Portugal and Morocco are major suppliers of dehydrated tomatoes, although imports from France may include re-exports of Moroccan produce. The United States supplies a wide range of dehydrated vegetables, including in 1970, large quantities of onions and potatoes.

d. Imports of onions

Unfortunately figures for Netherlands imports of onions are not available for 1960, however imports increased by 227 per cent between 1961 and 1969, from 914 tons valued at £172,900 (\$ 484,000) to 2,789 tons valued at £750,600 (\$ 1.80 million) and there was a further increase to 3,114 tons valued at £1.02 million (\$ 2.45 million) in 1970 (see Table 11). However, as has already been explained, the Netherlands re-exports substantial quantities of onions; in recent years about a quarter of total imports have been re-exported.

Throughout this period Egypt and Hungary have been the main supplying countries although in the earlier part of the period Egypt was the major supplier while latterly Hungary has been the more important. In 1969 Hungary supplied 35 per cent of total imports, and Egypt 23 per cent, the United States accounted for 10 per cent and Germany 8 per cent (re-exports from East European countries). Roumania was an important supplier from 1964 onwards, but in 1969 she supplied only 6 per cent of Netherlands' imports compared with 23 per cent in 1970. Other suppliers to this market in recent years include Lebanon, Poland, USSR and the People's Republic of China; in 1970 Czechoslovakia and Algeria supplied this market for the first time, accounting for 4 per cent and almost 2 per cent of the market respectively.

e. Imports of tomatoes

Although imports of dehydrated tomatoes were not shown separately in the Trade Returns before 1970, estimates of imports prepared by the *Produktschap voor Groeten en Fruit* are available for the years 1967 to 1969. There has been a rising trend in imports from 730 tons in 1967 to 1,048 tons valued at £495,400 (\$ 1.19 million) in 1970. Tomatoes are thus second in importance to onions in total imports of dehydrated vegetables. The major supplier to this market is Italy, who supplied 50 per cent of total imports in 1970, followed by France (25 per cent), Portugal (15 per cent) and Switzerland (5 per cent). Direct imports from Morocco accounted for only 3 per cent of the total.

The importance of dehydrated tomatoes in the Netherlands is probably due to the fact that tomato soup is the most popular type of dried soup sold in that country (9).

f. Imports of other vegetables

Although details of imports of vegetables other than onions were not available in the Trade Returns before 1970, estimates of imports of other vegetables are shown in Table 11.

According to the Trade Returns, **potatoes** were the most important item imported, amounting to 728 tons at a value of £97,100 (\$ 233,000). There were relatively few suppliers of this vegetable — Germany accounted for 67 per cent, the United States for 15 per cent and Poland for 10 per cent of the total tonnage imported. In 1970 672 tons of **carrots** valued at £158,800 (\$ 381,000) were imported, the major suppliers being Germany (36 per cent) and Israel (33 per cent), other suppliers included Roumania (8 per cent), Kenya (7 per cent), Poland and Belgium (both 4 per cent), the United Kingdom and China.

Leeks were imported from a large number of countries, including Germany, Portugal, Yugoslavia, Hungary, Egypt, Bulgaria, Roumania, Kenya and Turkey; total imports in 1970 amounted to 384 tons valued at £159,000 (\$ 382,000). **Celeriac** is imported almost entirely from East European countries, Hungary alone supplied 70 per cent of the total imports of 127 tons, valued at £63,700 (\$ 152,900) in 1970. Although the tonnage of **mushrooms** imported is not very large (103 tons

in 1970) this item is an expensive one and the imports were valued at £162,000 (\$ 389,500). The sources of supply included Germany (38 per cent), France (22 per cent) and Taiwan (14 per cent), also Roumania, the Irish Republic, Yugoslavia, the People's Republic of China and Japan. Imports from Germany are chiefly of *B. edulis* mushrooms of East European origin. The Netherlands re-exports mushrooms, chiefly to the United Kingdom — in 1970 exports mounted to 28 per cent of imports.

Imports of beans, in this year were of relatively little significance, amounting to only 39 tons, valued at £16,400 (\$ 39,400). Half these imports came from Belgium and 38 per cent from Germany.

The quantity of unspecified types of vegetables imported amounted to 506 tons in 1970 of which 174 tons or 34 per cent came from Germany. Imports under this category are thought to be chiefly of spinach, cabbage, garlic, herbs and asparagus.

Exports and Re-Exports

The Netherlands is now one of the world's major exporters of dehydrated vegetables and is by far the largest exporter in Europe. A summary of the tonnages of different types of vegetables exported is shown opposite in Table 13.

Total exports increased from 2,479 tons in 1960 to 6,766 tons in 1969 — an increase of 173 per cent, however there was a decline in the tonnage exported in 1970 to 5,910 tons. Dehydrated potatoes form a major percentage of exports — 59 per cent in 1969 (and have accounted for most of the increase in exports) followed by onions (re-exports) amounting to 11 per cent of the total, carrots 5 per cent, French beans 4 per cent and juliennes (mixed vegetables) 2 per cent in 1969. In 1970 when categories for celery (including celeriac) leeks, mushrooms and tomatoes were introduced, celery and celeriac accounted for 2 per cent of exports and leeks for 3 per cent while dehydrated mushrooms and tomato exports were of negligible importance. The Netherlands' exports of dehydrated vegetables are made mainly to other West European countries. Germany is the main market, taking 64 per cent of total exports and 92 per cent of dehydrated potato exports in 1969. The United Kingdom is another important market, taking 14 per cent of total exports in 1969 and being the major importer of onions and "other vegetables" in recent years.

Net Demand for Dehydrated Vegetables

Unfortunately it is very difficult to estimate net demand for all dehydrated vegetables in the Netherlands, owing to the lack of production statistics for potatoes, a major production export item. However, it is possible to estimate net demand for vegetables other than potatoes — see Table 14 (based on Tables 11 and 13) page 42 — though the estimate for 1970 is better than those for 1968 and 1969 owing to the publication in 1970 of separate import statistics for potatoes. The table also shows net demand for vegetables which are almost wholly imported.

The Netherlands' demand for dehydrated vegetables (excluding potatoes) rose by an estimated 38 per cent between 1968 and 1970, while demand for onions rose less rapidly — by 32 per cent, over the same period, and estimated demand for dehydrated tomatoes increased by less than 10 per cent.

Structure of the Trade

The Netherlands' trade in dehydrated vegetables is relatively simple compared with the United Kingdom's since catering demand for dehydrated vegetables is still very limited and the dried soup and other manufacturers are virtually the only buyers.

Table 13
Exports of Dehydrated Vegetables from the Netherlands 1960-1970

		Onions	Potatoes	Juliennes	Carrots	Beans	Tomatoes	Leeks	Celery	Mushrooms	Others	TOTALS
1960	tons £'000	290 60.0	1,042 165.7	101 35.3	132 49.5	131 93.1	...	...	...	...	783	2,479
1961	tons £'000	220 53.5	975 156.9	104 36.9	140 55.4	141 101.8	21 11.4	...	...	...	406.3	809.9
1962	tons £'000	196 71.4	980 175.2	141 52.8	222 87.5	211 160.5	0.2	...	...	...	869	2,470
1963	tons £'000	108 44.4	470 88.5	258 97.4	176 71.4	313 224.2	6 4.7	...	...	...	511.4	927.3
1964	tons £'000	273 88.2	695 143.0	81 33.6	84 32.5	270 206.7	2 1.4	...	...	...	1,085	2,835
1965	tons £'000	395 113.6	1,050 218.0	80 32.7	146 56.8	201 152.7	3 1.9	...	...	...	611.1	1,158.7
1966	tons £'000	369 158.6	1,089 221.3	108 54.4	161 73.9	253 188.5	...	...	...	...	1,211	2,542
1967	tons £'000	495 169.7	3,340 622.3	142 66.1	305 109.9	280 212.0	...	...	...	...	758.8	1,289.4
1968	tons £'000	566 226.3	3,496 749.6	156 85.9	353 150.6	285 247.1	...	...	...	...	1,102	2,507
1969	tons £'000	780 317.7	3,972 840.1	111 59.7	313 141.6	288 249.0	...	...	...	...	774.5	1,279.9
1970	tons £'000	779 401.2	3,405 764.0	143 81.6	278 99.8	205 174.7	19 8.0	188 134.7	135 102.6	29 62.2	917	5,910
											610.1	2,438.9

Source: *Maandstatistiek van de In- en Uit-voer*
Centraal Bureau voor de Statistiek

Not separately shown, included with "others".

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Table 14
Estimated Net Demand for Dehydrated Vegetables in the Netherlands
Metric Tons

	Domestic Production (1).	Imports (2)	Exports (3)	Net Demand (1+2-3)
1968 All vegetables excluding potatoes	3,100	(4,400)	2,641	(4,860)
of which Onions	-	2,340	566	1,774
Tomatoes	-	(949)	-	(950)
1969 All vegetables excluding potatoes	3,100	(5,000)	2,794	(5,300)
of which Onions	-	2,789	780	2,009
Tomatoes	-	(948)	-	(950)
1970 All vegetables excluding potatoes	3,200	5,993	2,505	6,690
of which Onions	-	3,114	779	2,335
Tomatoes	-	1,048	19	1,029
Mushrooms	-	103	29	74

Sources: (1) *Fruit Intelligence*
(2) and (3) *Published Trade Statistics and*
() *Produktschap voor Groeten en Fruit*

In view of the importance of the Netherlands' dehydration industry, manufacturers buy a large proportion of their requirements direct from domestic producers (some of whom also buy imported vegetables, especially onions, in order to increase their range).

Imports may be bought direct from the overseas producers or through importers and agents; the major soup manufacturers buy most of their import requirements direct while other users buy through importers.

a. Importers and agents

According to the Vegetable and Fruit Board (Produktschap voor Groeten en Fruit) there are about 10 importers in the Netherlands who handle dehydrated vegetables, although only 3 or 4 firms specialise in these products. The specialist importers hold sole agencies for some overseas producers and also trade as principals or on their own account (i.e. buy outright). One importer is also linked with a domestic producer of dehydrated vegetables.

b. Direct-buying

A major proportion of dehydrated vegetables used in the Netherlands is bought by manufacturers direct from the domestic producers, indeed several of the major soup manufacturers own dehydration plants which supply a proportion of their requirements. Co-operation between manufacturers of dehydrated vegetables and their customers is a feature of the trade. Nevertheless, the rising prices of Dutch dehydrated produce relative to imported produce has encouraged major users to import a larger proportion of their requirements and frequently to buy direct from overseas producers. Since there is no established retail market for dehydrated vegetables, no retail concerns buy dehydrated vegetables direct from either domestic or overseas producers.

Outlets

Although dehydrated vegetables can be substituted for fresh vegetables in a variety of food products, they are not widely used in the Netherlands and dried soup manufacture remains the dominant outlet for dehydrated vegetables, possibly accounting for as much as 90 per cent of total demand for imports.

The three categories of outlet which will determine the future demand for dehydrated vegetables in the Netherlands are: dried soup manufacturers, other food manufacturers

and the catering and retail trade in culinary vegetables. These sectors are examined in detail below:

a. Dried soup manufacturers

Soup is not identified in the officially published production and consumption statistics but estimates made by the Economist Intelligence Unit (10) suggest that about two-thirds of all soup consumed by private households in the Netherlands is prepared at home, being either entirely home-made or prepared with manufactured flavours and additives (including packet soups). The remaining third consists of packet and canned soups whose share in the total has increased in recent years. The Netherlands' market for industrially-prepared soups is virtually self-sufficient and Dutch producers export large tonnages to Belgium where they have a major share of the market. Netherlands' consumption of dried soups is estimated to have risen from 70 million litres (reconstituted) in 1957 to 130 million litres in 1967 and to 160 million litres in 1969. Consumption of canned soups rose even faster – from 20 million litres in 1957 to 45 million litres in 1967 and 85 million litres in 1969. It is forecast that sales of packet soups will increase at a lower rate while sales of canned soups will continue to expand rapidly in the near future. Although not all packet soups are made from dehydrated vegetables, the increase in sales of dried soups over the period 1957 to 1969 obviously explains the increasing demand for dehydrated vegetables over this period, particularly as vegetable and tomato are the most popular types of soup.

The market leaders in the dried soup sector are Royco (Unilever) and Honig followed by California (AKZO Group), Knorr (Corn Products) and some way behind, Maggi (Nestlé). These companies are estimated to have 96 per cent of the market (11). It is of interest that the two non-international soup brands (Honig and California) have a substantial share of the Netherlands' market, in contrast to the situation in most other countries. Several of these companies also manufacture canned and dried ready-meals.

Exports of dried soups, bouillon cubes etc rose from 5,644 tons in 1966 to 6,555 tons in 1968 and then fell again to 5,888 tons in 1970. Belgium took the bulk of these exports.

Dried soup manufacturers use substantial quantities of freeze-dried vegetables in spite of the fact that rapid cooking is less important as a selling point than in the United Kingdom.

b. Other food manufacturers

Usage of dehydrated vegetables in foods other than dried soups is still rather limited in the Netherlands, but is expected to increase. The main users are meat packers and canned soup manufacturers who use onions, leek etc when fresh supplies are expensive or unavailable. Dehydrated vegetable powders are used as flavourings in a variety of food products and for the manufacture of baby foods. However the specifications for dehydrates used in baby foods are very stringent as regards bacterial limits. Dried ready-meals seem to be a promising outlet for dehydrated vegetables. There are a number of manufacturers of dried ready-meals, including Royco (Unilever), Honig and Maggi (Nestlé) and the range of meals is wider than that found in the United Kingdom, extending from Indonesian dishes through pasta dishes to hashes (a mixture of potato, vegetables and a little meat). However no brand of ready-meals is as well-established as the Vesta (Unilever) brand in the United Kingdom, and there is some uncertainty as to the future trend in sales.

c. Catering and retail trades

It has already been mentioned that sales of dehydrated vegetables for catering purposes are at present very limited in the Netherlands. There are two reasons for this, in the first place people who remember using dehydrated vegetables during the War are prejudiced against them and secondly the Netherlands offers fewer opportunities for demand from large catering concerns than the United Kingdom since industrial canteens are the exception rather than the rule. Nevertheless, the

armed forces provide a small outlet for dehydrated vegetables and hospitals and some residential institutions are beginning to buy dehydrated vegetables as, to a limited degree, are restaurants providing cheaper meals.

In contrast to the United Kingdom where the types of vegetables used in the catering trade are those suitable for serving alone — peas, beans, mixed vegetables etc, in the Netherlands catering demand is chiefly for vegetable mixes for use in the preparation of soups and stews, although there is some demand also for peas and sliced French beans. Packets of mixed vegetables are also sold at retail level for the preparation of Indonesian and Chinese dishes and Nestlé has recently introduced a retail pack of freeze-dried onions on to the market.

Processors of dehydrated vegetables in the Netherlands are of the opinion that catering demand will increase rapidly although it will probably never comprise such an important share of the market as it does in the United Kingdom.

Terms of Trade and Margins

Dehydrated vegetables are invariably bought against sample and the dried soup manufacturers have very strict specifications for dehydrated vegetables. If a consignment does not come up to specification the producer may be asked to pay compensation or to replace the consignment.

Importers and those companies which buy direct generally trade on cif or c and f terms, although Egyptian onions are bought fob.

Prices

Since the dried soup manufacturers who buy most of their supplies direct from producers occupy such a dominant position in the Netherlands market, the prices of dehydrated vegetables are not published. The only price data available are the annual average cif values for imported vegetables compiled from the official trade statistics, as shown in Table 15 below.

Table 15
Average Annual cif values of Dehydrated Vegetables imported into the Netherlands
£ per metric ton

Year	Onions	Tomatoes	Carrots	Leeks	Mushrooms	Beans	Celery & Celeriac	Potatoes	Others
1960	...	...	...	...	...	...	...	...	289
1961	189	...	...	...	...	...	...	...	533
1962	268	...	...	...	...	...	...	...	467
1963	259	...	...	...	...	...	...	...	438
1964	213	...	...	...	...	...	...	...	430
1965	196	...	...	...	...	...	...	...	462
1966	216	...	...	...	...	...	...	...	389
1967	210	(469)	(202)	(288)	(1184)	(716)	(384)	...	(429)
1968	247	(534)	(232)	(448)	(1288)	(790)	(458)	...	(514)
1969	269	(525)	(252)	(405)	(1397)	(681)	(425)	...	(378)
1970	328	472	236	414	1576	421	501	133	516

Sources derived from *Maandstatistiek van de In-Uit-voer*
and () figures provided by *Produktschap voor Groeten en Fruit*

Table 15 shows that average import values of dehydrated onions followed a downward trend from 1962 to 1965 after which it was reversed. The average values of unspecified types of vegetables declined from 1961 to 1964 and thereafter fluctuated from year to year. It should be noted that the apparent rise in values between 1967 and 1968 is partly accounted for by the conversion of guilders to

sterling, the latter currency having been devalued by 14.3 per cent at the end of 1967. It is interesting to note that the average values of dehydrated vegetables imported into the Netherlands were lower than the values of United Kingdom imports for those vegetables where a comparison is possible (onions, potatoes and tomatoes). This difference may be due to differences in cut etc, for example the Netherlands imports a greater proportion of tomato flake than the United Kingdom and the latter country imports diced potatoes rather than the cheaper powdered potato.

Although the average import values calculated from the Trade Returns give some indication of the level of price for certain types of dehydrated vegetables, in actual fact prices for each type of vegetable vary considerably according to the quality, cut and other characteristics. In addition prices may change rapidly owing to the market situation; for example at the end of 1970 quoted prices for onions were at very high levels, ranging from £460 to £540 per ton (\$ 1,100 to \$ 1,300 per ton) for kibbled onion, but within a few months supplies had eased and prices had fallen to approximately half.

Belgium/Luxembourg

Belgium and Luxembourg hardly constitute a separate market for dehydrated vegetables — as has already been explained, many of the soup manufacturers in the Netherlands supply the Belgian market from their Dutch plants and imports of dehydrated vegetables into Belgium are at a lower level than imports into any other Western European country shown in Table 2, with the exceptions of Denmark and Finland. Also in recent years exports or re-exports of dehydrated vegetables have exceeded imports. It would probably be correct to consider the Benelux countries (Belgium, Netherlands and Luxembourg) as a single market for dehydrated vegetables.

Domestic Production

The full extent of the domestic dehydration industry is not known and there are no production statistics. However, there is known to be one processor who produces some dehydrated vegetables including celery, celeriac, leeks, carrots and shallots — probably a few hundred tons a year — though the production of dried herbs is of greater importance to this company. Clearly there is at least one other processor since exports of potatoes exceeded imports by a considerable margin in 1970.

Imports

a. Total import demand

Table 16 shows that imports have fluctuated considerably but showed an underlying upward trend, rising from 181 tons valued at £51,200 (\$ 143,000) in 1960 to 504 tons valued at £239,200 (\$ 574,000) in 1969 before dropping again to 430 tons in 1970. In fact the upward swing in demand has occurred in the years since 1967.

b. Types of vegetables imported

Until 1970 onions were the only vegetable shown in a separate import category in the Belgian Trade Returns, but in that year separate categories for potatoes, leeks and celery and celeriac were introduced — see Table 16.

Table 16
Imports of Dehydrated Vegetables into Belgium/Luxembourg 1960-1970

Year		Onions	Potatoes	Leek	Celery	Others	TOTALS
1960	tons £'000	...	...	...	...	181 51.2	181 51.2
1961	tons £'000	29 7.6	...	...	...	93 38.1	122 45.7
1962	tons £'000	41 11.9	...	...	...	79 34.3	120 46.2
1963	tons £'000	49 15.9	...	...	...	104 52.2	153 68.1
1964	tons £'000	48 15.3	...	...	...	125 48.3	173 63.6
1965	tons £'000	107 18.1	...	...	...	119 45.7	226 63.8
1966	tons £'000	70 18.5	...	...	...	112 46.2	182 64.7
1967	tons £'000	60 18.1	...	...	...	169 57.8	229 75.9
1968	tons £'000	83 32.5	...	...	...	204 100.4	287 132.9
1969	tons £'000	160 59.9	...	...	...	344 179.3	504 239.2
1970	tons £'000	145 58.3	73 18.3	37 19.7	9 5.1	166 124.0	430 225.4

Source: *Commerce Exterieur*
L'Institut National de Statistique ... Not separately shown

Imports of onions fluctuated from year to year and in recent years comprised approximately a third of total imports. In 1970 the relative importance of various types of dehydrated vegetables was as follows:-

	Onions	Potatoes	Leeks	Celery and Celeriac	Others
Per cent	34	17	9	2	38

The "others" category includes imports of tomatoes, garlic, mushrooms, asparagus, sweet peppers and herbs. It seems likely that imports of herbs, especially parsley, chervil and tarragon are proportionately more important than is the case with most other European countries.

c. Sources of supply

Unfortunately the Belgian trade statistics provide little information concerning the sources of imports of dehydrated vegetables. Table 17 shows the major suppliers of dehydrated vegetables to Belgium for the period 1965 to 1969.

The major source of imports during this period has been the Netherlands, except in 1967 and 1969 when France was the major supplier; Germany is also an important source of imports. In 1968 and 1969 the Netherlands, France and Germany together supplied respectively 66 and 70 per cent of total imports. Imports from Morocco were of importance in 1968 and 1969, amounting to 12 per cent of the total in the latter year. Imports from the United States (chiefly dehydrated onions) have increased in importance in recent years. In 1970 the People's Republic of China was shown as a supplier (of onions and leeks) for the first time.

Table 17
Imports of Dehydrated Vegetables into Belgium/Luxembourg by country of origin

		1965	1966	1967	1968	1969	Percentage 1969 imports
TOTALS of which from:-	tons £'000	226 63.8	182 64.7	229 75.9	287 132.9	504 239.2	100
Netherlands	tons £'000	159 32.1	81 26.1	42 14.4	90 36.8	134 61.3	26.6
France	tons £'000	15 5.1	9 6.8	100 28.4	48 36.5	152 86.8	30.2
German Fed Rep	tons £'000	19 10.1	33 10.5	...	53 23.5	68 33.7	13.5
Morocco	tons £'000	...	...	...	32 8.6	62 18.6	12.3
United States	tons £'000	4 3.8	8 4.7	...	19 5.0	29 8.3	5.8
Hungary	tons £'000	...	6 1.6	...	...	...	...
Other Countries	tons £'000	29 12.7	45 15.0	87 33.1	45 22.5	59 30.5	11.7

... Not separately shown

Source: *Commerce Exterieur*
L'Institut National de Statistique

d. Imports of onions

Separate statistics for imports of dehydrated onions were not available in the Belgian Trade Returns until 1961. Imports in that year amounted to only 29 tons valued at £7,600 (\$ 21,300) but by 1969 imports had increased to 160 tons valued at £59,900 (\$ 144,000) before declining somewhat to 145 tons in 1970. A proportion of imports is subsequently re-exported — exports amounted to as much as two-thirds of the quantity imported in 1967 and to 36 per cent in 1969.

Throughout the period 1961 to 1969 the Netherlands was the main source of supply of dehydrated onions, usually accounting for at least half the quantity imported, but in 1970 imports from the United States exceed those from the Netherlands. Germany and France are other sources of supply and in 1970 the People's Republic of China supplied 20 per cent of total imports.

e. Imports of other vegetables

The 1970 Trade Returns show that dehydrated potatoes were imported entirely from EEC sources, and the small quantities of celery and celeriac imported also came chiefly from other EEC countries. However the People's Republic of China was the main supplier of leek (44 per cent) followed by France (32 per cent) and the Netherlands (21 per cent).

Imports of unspecified types of vegetables in 1970 were supplied chiefly by EEC countries — France (34 per cent), the Netherlands (25 per cent) and Germany (8 per cent), also by Morocco (9 per cent) and the United Kingdom (2 per cent). Imports from France may have included dehydrated tomato products of Moroccan origin — imports received direct from Morocco were almost certainly largely of tomato products.

Exports and Re-Exports

Unusually among European countries except the Netherlands, Belgium has in recent years exported rather larger quantities of dehydrated vegetables than she has imported. It must be assumed that a proportion of total exports is in fact re-exported

produce (onions, for example), however the bulk of exports are probably of domestic origin.

Belgian exports from 1960 to 1970 are summarised in Table 18. Exports of onions have fluctuated considerably over this period, but exports of other vegetables have risen strongly since 1963, probably as a result of increasing exports of potatoes (judging by the data for 1970). Between 1963 and 1970 total exports from Belgium rose from 39 tons to 794 tons.

Table 18
Exports of Dehydrated Vegetables from Belgium/Luxembourg 1960-70

Year		Onions	Potatoes	Leek	Celery & Celeriac	Others	TOTALS
1960	tons £'000	...	...	...	...	41 9.9	41 9.9
1961	tons £'000	12 1.9	...	...	...	13 5.4	25 7.3
1962	tons £'000	9 3.0	...	...	...	58 18.5	67 21.5
1963	tons £'000	1 0.3	...	...	...	38 15.5	39 15.8
1964	tons £'000	- 0.1	...	...	...	89 33.2	89 33.3
1965	tons £'000	3 0.9	...	...	...	110 46.6	113 47.5
1966	tons £'000	16 5.8	...	...	...	213 83.3	229 89.1
1967	tons £'000	41 19.1	...	...	...	267 122.9	308 142.0
1968	tons £'000	12 5.6	...	...	...	309 111.1	321 116.7
1969	tons £'000	58 7.4	...	...	...	447 110.2	505 117.6
1970	tons £'000	11 3.9	630 83.8	32 14.9	22 13.9	99 69.0	794 185.5

Source: *Commerce Exterieur* ... Not available
L'Institut National de Statistique

In 1970 the relative importance of the different vegetables exported was as follows:-

	Potatoes	Leek	Celery and Celeriac	Onions	Others
Per cent	79	4	3	1	13

Germany is the major market for Belgian exports. In 1970 potatoes were exported almost entirely to Germany, also the largest market for celery and celeriac and for unspecified types of vegetables. Italy was second in importance as a market for unspecified types of vegetables.

Net Demand for Dehydrated Vegetables

In view of the absence of production figures for Belgium, it is not possible to estimate net demand.

Structure of the Trade

The Belgian trade in dehydrated vegetables is very limited and the structure of the trade is very simple. The major buyer of dehydrated vegetables in Belgium is a dried soup manufacturer, but other manufacturers use small quantities in canned soups and fish and meat products. The major user buys direct from producers as far as possible.

The import trade is dominated by a single importer, most of whose business is in fact outside Belgium, for example exporting French dehydrates to the United States. The firm probably handles 90 per cent of Belgian imports (apart from the quantities imported direct), the remaining 10 per cent being handled by a number of importers of food manufacturers' supplies. The major importer buys and sells as a principal and is seeking new suppliers outside Europe.

Outlets

Since Belgium has only one dried soup manufacturer outlets for dehydrated vegetables are necessarily limited. However, usage by other manufacturers, and even in the catering trade is increasing on account of the convenience of using ready-prepared vegetables. The three sectors of the trade are examined below.

a. Dried soups

The Benelux countries (Belgium, Netherlands and Luxembourg) effectively constitute a single market for dried soups, most of the production capacity being in the Netherlands. There is only one manufacturer of dried soups in Belgium — Brooke Bond Liebig SA, part of an international food manufacturing company which does not however figure largely in the manufacture of dried soups.

In Belgium, as in the Netherlands, home-made soup accounts for the largest part of soup consumed and the market for canned and packet soups is further limited by the fresh soup industry which flourishes outside large towns. Soup is made fresh each day in large batches and delivered to local customers. The market for canned soup, still a novelty, is in fact increasing, but Dutch exports of dried soup, bouillons and soup preparations to Belgium showed a downward trend from a peak of 5,715 tons in 1968 to 4,969 tons in 1970 and Liebig do not expect any increase in demand.

b. Other manufacturers

A number of manufacturers of fish and meat products and canned soups use dehydrated vegetables, especially onions. Demand is expected to increase.

c. Catering and retail trade

Dehydrated onions are used in increasing quantities by industrial caterers and restaurants, although attempts to sell dehydrated sliced onions on the retail market have not been successful. However, sales of onion and garlic salts (based on powdered onion and garlic) as cooking aids are important in Belgium. Demand in the catering and retail trade sector is expected to increase.

Prices

There is no published series of prices for dehydrated vegetables on the Belgian market but some indication of the prices paid for imports may be obtained from the official imports statistics as shown in the table below:-

Table 19: Belgium/Luxembourg: Average Annual cif values of Imported Dehydrated Vegetables £ per ton

Year	Onions	Potatoes	Leeks	Celery and Celeriac	Others
1960	...	...	...	...	283
1961	262	...	...	...	412
1962	290	...	...	...	434
1963	321	...	...	...	505
1964	319	...	...	...	387
1965	169	...	...	...	384
1966	264	...	...	...	411
1967	302	...	...	...	343
1968	392	...	...	...	493
1969	374	...	...	...	521
1970	402	252	532	554	749

Source: *Commerce Exterieur, L'Institut National de Statistique*

Average import values have fluctuated from year to year but since 1965 have shown an upward trend. Part of the sharp increase in prices between 1967 and 1968 may be accounted for by the conversion of Belgian francs into sterling, the latter currency having been devalued by 14.3 per cent in late 1967. It is of interest that the average values of imports in 1970 exceeded the values of United Kingdom imports possibly because of the small quantities bought by Belgian users.

France

Considering the size of her population France is a relatively small importer of dehydrated vegetables, partly because of her own sizable dehydration industry which is protected from competition from producers outside the EEC by an import licensing system and also because of low per caput consumption compared with the United Kingdom, Germany and the Netherlands. France is a quite important exporter but she became a net importer for the first time in 1967 and exports declined from 1965 to 1969 before recovering somewhat in 1970, whilst imports have been increasing steadily.

Domestic Production

There are several producers of dehydrated vegetables in France (five or six) including two with freeze-drying equipment. The largest manufacturer of dehydrated vegetables is a subsidiary of Nestlé.

According to figures supplied by the Syndicat des Deshydrateurs French production of dehydrated vegetables amounted to 3,060 tons from May 1968 to April 1969 and rose to 3,883 tons in the following twelve months – an increase of 27 per cent. Production of various types of vegetables was as follows:-

	1968-69	1969-70	Tons
Potatoes	1,017.6	1,401.9	
Onions	605.9	600.3	
Tomato powder	530.4	589.5	
Tomato flakes	236.0	348.6	
Asparagus	143.0	159.4	
Carrots	95.3	242.9	
Garlic	91.8	133.4	
Leeks	76.3	97.5	
Spinach	42.8	36.5	
Parsnips & Turnips	28.0	30.5	
Cress	20.3	23.5	
Mushrooms	32.5	11.8	
Betteraves	-	23.2	
Cabbage	-	29.0	
Shallots	13.8	15.9	
Jerusalem Artichoke	22.1	7.3	
Celeriac	8.9	10.2	
Green Beans	6.5	18.8	
Sweet Peppers	5.3	5.5	
Herbs	81.4	95.8	
Others	2.1	1.6	
TOTALS	3,060.0	3,883.0	

Potatoes, onions and tomato products together accounted for 78 per cent of total production in 1968-9 and for 75 per cent in 1969-70; potatoes were the major item, accounting for 33 per cent of the total in 1968-9 and for 36 per cent in 1969-70. Apart from these three items, French manufacturers process a wide range of vegetables among which asparagus, carrots, garlic and leeks are the most important.

French production of dehydrated vegetables is expected to increase in future years.

Imports

a. Total import demand

France is not at present a major importer of dehydrated vegetables and imports from countries outside the EEC are limited by the import licencing regulations. However Table 20 shows that imports sustained a steady upward trend from 1967 to 1970 broken only by a peak in 1963 after a very cold winter. Imports in 1961 amounted to only 176 tons valued at £150,800 (\$ 422,200), but by 1969 imports had risen to 1,502 tons valued at £1,077,000 (\$ 2.58 million) and further to 1,817 tons valued at £1,551,700 (\$ 3.72 million) in 1970.

Table 20
Imports of Dehydrated Vegetables into France 1960 to 1970

		Onions	Potatoes	Others	TOTALS
1960	tons	...	22	282	304
	£'000	...	3.6	121.2	124.8
1961	tons	48	-	128	176
	£'000	10.0	-	140.8	150.8
1962	tons	101	-	304	405
	£'000	30.1	-	349.7	379.8
1963	tons	545	-	341	886
	£'000	187.7	-	366.5	554.2
1964	tons	244	-	359	603
	£'000	76.8	-	325.0	401.8
1965	tons	149	27	449	625
	£'000	45.0	6.4	421.7	473.1
1966	tons	263	6	487	756
	£'000	73.7	1.8	462.2	537.7
1967	tons	394	-	768	1,162
	£'000	109.0	-	629.8	738.8
1968	tons	402	7	855	1,264
	£'000	112.6	1.9	835.9	960.4
1969	tons	304	...	1,198	1,502
	£'000	83.2	...	993.8	1,077.0
1970	tons	385	...	1,432	1,817
	£'000	136.7	...	1,415.0	1,551.7

... Not separately shown

- Nil or negligible

Source: *Commerce Exterieur*
Direction Generale des Douanes et Droits Indirects

b. Types of vegetables imported

Onions and potatoes were the only types of vegetables shown in separate categories and imports of potatoes have been spasmodic. Import licences are granted only for dehydrated vegetables which are not manufactured in France (e.g. *B. edulis* mushrooms) or when French production is insufficient to meet demand (e.g. onions, tomatoes).

Onions are the principal type of vegetable imported but the importance of this vegetable in total imports has declined from 61 per cent in 1963 (after a very cold winter which probably affected domestic production) to about 20 per cent in 1969 and 1970. Imports of potatoes have been sporadic and of very little importance.

The "other vegetables" category includes *B. edulis* mushrooms, tomatoes, carrots, celeriac and herbs.

c. Sources of supply

Table 21 summarises French imports of dehydrated vegetables by supplying country for the years 1965 to 1969. The major sources of imports during this period have been Israel (this country has a special agreement with France,

permitting exports of onions, carrots and leeks against a quota), Yugoslavia (a major source of *B.edulis* mushrooms) and Morocco (who also enjoys special terms of access to the French market). East European countries are of limited importance as suppliers to this market. Fellow-members of the EEC — the Netherlands, Germany and Italy — were not significant suppliers prior to 1969, the tariffs between member countries were finally removed in 1969.

The first five countries listed in Table 21 supplied 52 per cent by weight of total imports over this period, and the first 10 countries supplied 79 per cent. The proportion of the total tonnage supplied by each country in 1969 is shown in the final column. Quantities imported from individual supplying countries, and hence their relative importance, have fluctuated quite widely from year to year.

Table 21
Imports of Dehydrated Vegetables into France by country of origin

		1965	1966	1967	1968	1969	% of total in 1969
TOTALS	tons	625	756	1,162	1,264	1,502	
of which from:-	£'000	473.1	537.7	738.8	960.4	1,077.0	
Israel	tons	124	85	120	145	228	15.2
	£'000	34.3	26.2	36.2	46.3	67.6	
Yugoslavia	tons	124	131	145	149	112	7.5
	£'000	126.3	137.6	157.4	144.9	98.3	
Morocco	tons	66	59	110	126	179	11.9
	£'000	25.8	27.1	56.5	68.9	97.9	
Roumania	tons	31	32	184	81	120	8.0
	£'000	28.6	24.8	87.0	50.4	90.9	
UAR Egypt	tons	-	145	128	157	-	
	£'000	-	40.1	34.5	43.8	-	
Spain	tons	108	24	92	112	76	5.0
	£'000	40.2	9.2	34.3	37.3	28.7	
United States	tons	-	-	45	112	187	12.4
	£'000	-	-	26.8	46.4	75.4	
Netherlands	tons	28	60	23	25	141	9.4
	£'000	17.2	53.8	16.7	18.4	86.4	
Hungary	tons	-	-	89	76	30	2.0
	£'000	-	-	20.1	33.1	19.8	
Germany	tons	37	7	13	34	112	7.5
	£'000	13.9	4.7	15.1	28.7	82.5	
Bulgaria	tons	-	-	60	19	77	5.1
	£'000	-	-	52.6	23.5	81.0	
Italy	tons	-	7	10	36	94	6.3
	£'000	-	5.1	8.3	23.5	61.5	
United Kingdom	tons	-	45	21	44	32	2.1
	£'000	-	12.5	6.1	18.7	7.7	
China	tons	18	18	15	36	22	1.5
	£'000	16.9	17.2	15.4	49.5	31.3	
Other Countries	tons	89	143	107	112	92	6.1
	£'000	169.9	179.4	171.8	327.0	248.0	

-Nil or negligible

Source: *Commerce Exterieur*

d. Imports of onions

Data for French imports of dehydrated onions are not available for 1960; since 1961 imports have fluctuated from year to year, the peak being in 1963 after an exceptionally cold winter. Imports have been at a higher level in the years 1966 to 1969 — average 350 tons — than in the years 1961 to 1965 (excluding 1963) when they averaged 136 tons; however, the level has remained remarkably stable over the last few years and in 1970 385 tons valued at £136,700 (\$ 328,000) were imported. It has already been explained that French imports are limited by the availability of import licences, which in turn depends largely on the supplies of domestically produced dehydrated vegetables.

In recent years the major suppliers of dehydrated onions to the French market have been Egypt, Israel and the United States. In 1963, 1964 and from 1966 to 1968 Egypt was the major supplier to this market, accounting for 34 per cent of total imports in 1968. However, in 1965 and 1969 supplies from this source were nil or

negligible. Israel has been a consistent supplier since 1963, and since 1966 imports from this source have ranged between 50 and 55 tons per annum (accounting for 18 per cent of supplies in 1969). The United States has entered this market relatively recently — imports from this source rose from 38 tons in 1967 to 165 tons (54 per cent of the total) in 1969 and to 226 tons (59 per cent of the total) in 1970; the dominant position of the United States in 1970 and possibly in 1969 may be due to general shortages on the world market due to crop failures in East European and Middle European countries. Other suppliers have included Spain (in most recent years apart from 1966 and 1969), Hungary, Roumania, the United Kingdom, Germany and the Netherlands — supplies from the last three named clearly being re-exports.

e. Imports of potatoes

Imports of dehydrated potatoes have been very sporadic and reached a peak of 27 tons valued at £6,400 (\$ 17,900) in 1965 when 22 tons were supplied by Germany.

f. Imports of other vegetables

Imports of vegetables other than onions and potatoes have shown a steady upward trend since 1961 when only 128 tons valued at £121,200 (\$ 339,400) were received, to 1,432 tons valued at £1,415,000 (\$ 3.40 million) in 1970 — an increase of over 1000 per cent in tonnage over this period.

The major suppliers of imports have been Yugoslavia (mushrooms), Morocco (tomatoes), Israel (carrots and leeks) and Roumania (various vegetables). Other suppliers include Spain, the Netherlands, USSR, the People's Republic of China and Tunisia and very small tonnages of high value produce are imported from Pakistan, India and Japan.

Exports and Re-Exports

Before 1965 France was the second most important European exporter of dehydrated vegetables. Table 22 summarises French exports over the period 1960 to 1970 showing a rising trend from 874 tons in 1960 to 1,748 tons in 1965 followed by a decline to 835 tons in 1969 and a recovery to 1,256 tons in 1970. The reasons for declining exports in recent years seem to be increasing domestic demand and rising prices which have made French dehydrated vegetables uncompetitive on world markets.

Only two types of dehydrated vegetables are shown separately in the Trade Returns — potatoes, which before 1969 generally comprised over 15 per cent of total exports, and onions, which are of relatively little importance. The "other vegetables" category includes exports of asparagus, champignon mushrooms, tomatoes, leeks, spinach and various herbs.

Exports are made chiefly to other Western European countries — Germany, the Netherlands, the United Kingdom, Switzerland and Belgium, however the United States is also a major buyer and Canada and in some years Japan have also been of some importance.

Table 22
Exports of Dehydrated Vegetables from France 1960-1970

		Onions	Potatoes	Others	TOTALS
1960	tons £'000	...	26 2.7	848 421.3	874 424.0
1961	tons £'000	27 17.2	172 9.8	955 712.8	1,154 739.8
1962	tons £'000	28 7.1	146 31.0	1,073 734.5	1,247 772.6
1963	tons £'000	21 20.8	138 26.5	955 542.8	1,114 590.1
1964	tons £'000	26 10.1	296 63.4	1,001 517.3	1,323 590.8
1965	tons £'000	27 4.5	281 69.9	1,440 715.9	1,748 790.3
1966	tons £'000	4 0.7	60 19.0	1,216 642.6	1,280 662.3
1967	tons £'000	36 4.1	176 34.9	838 463.3	1,050 502.3
1968	tons £'000	29 11.0	262 28.0	629 527.8	920 566.8
1969	tons £'000	31 23.3	...	804 621.7	835 645.0
1970	tons £'000	31 12.2	...	1,225 875.5	1,256 887.7

... Not separately shown

Source: *Commerce Exterieur*

Net Demand for Dehydrated Vegetables

Since detailed statistics of French production of dehydrated vegetables are available for 1968-9 and 1969-70 it is possible to make estimates of net demand for all dehydrated vegetables and for some specific vegetables, although the production statistics year (May to April) does not exactly coincide with the import year (January to December).

Table 23
France: Estimated Net Demand for Dehydrated Vegetables
Metric Tons

		Domestic Production (1)	Imports (2)	Exports (3)	Net Demand (1) + (2) - (3)
1968	All vegetables of which	3,060	1,264	920	3,404
	Onions	606	402	29	979
	Potatoes	1,018	7	262	763
	Others	1,436	855	629	1,662
1969	All vegetables of which	3,883	1,502	835	4,550
	Onions	600	304	31	873
	Others	3,283	1,198	804	3,677

Sources: (1) *Syndicat des Deshydrateurs*
(2) and (3) *Commerce Exterieur*

Since data is available only for two years it is not possible to draw conclusions concerning trends in demand. However, it is interesting to note that demand for onions comprised 29 per cent of total demand in 1968 as against 19 per cent in 1969 though this analysis takes no account of the stock situation. Potatoes accounted for 22 per cent of total demand in 1968.

Imports accounted for 37 per cent of net demand for all vegetables in 1968 and for 33 per cent in 1969.

Structure of the Trade

Trade in imported dehydrated vegetables is circumscribed in France by the quota restrictions on imports from countries outside the EEC. Soup manufacturers are the only important buyers and obtain most of their supplies direct from domestic producers. These manufacturers may purchase their overseas supplies direct from producers if they are eligible for import licences (which depend on the value of companies' exports). The balance of the import trade is handled by general merchants, however none of these specialises in dehydrated vegetables owing to the uncertainty of obtaining import licences. Producers in Morocco and Israel sell through agents (both of these countries enjoy special entry to the French market) and the National Syndicat of Soup and Bouillon Manufacturers acts as a "post-box" for potential suppliers to French soup manufacturers.

Outlets

In spite of the possibilities of substituting dehydrated vegetables for fresh vegetables in a wide range of food products, they have not yet been adopted by many sectors of the French food industry and manufacturers of soups, especially dried soups, are still by far the most important buyers of dehydrated vegetables. Nevertheless in recent years the market for dehydrated vegetables has broadened to include other food manufacturers, and to a very minor extent the catering and retail trades. These market sectors will be examined in more detail below.

a. Dried soups

Dried soups have always dominated the French market for prepared soups and in spite of the rapid increase in sales of canned soups since 1966 (240 per cent between 1966 and 1969) production of dried soups in tonnage terms was twice that of canned soups in 1969.

The French soup and bouillon (stock cubes and concentrates) industry is well-documented and figures of soup production and usage of dehydrated vegetables in soups and bouillons are shown in the table below:-

Metric Tons

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Production										
Dried Soups	10,412	10,422	12,285	13,427	11,534	11,570	12,943	13,274	13,864	15,500
Canned Soups	1,786	1,218	1,335	1,855	1,957	2,015	2,204	3,336	4,953	7,500
Usage										
Dehydrated Onions	437	525	530	645	625	630	610	678	949	821
Dehydrated Potatoes*)	1,420	1,555	1,720	2,007	1,723	(896)	1,640	(788)	887	722
Other dehydrated vegetables)						(983)		(829)	900	2,026
Total dehydrated vegetables	1,857	2,080	2,250	2,652	2,348	2,509	2,250	2,295	2,736	3,569

Source: *Syndicat National des Fabricants de Bouillons et Potages*

* Includes small quantities of instant potato.

Production of dried soups rose by about 50 per cent between 1960 and 1969, the general upward trend being interrupted by a peak in 1962 and 1963 as the result of a very severe winter. It is of interest that French production of dried soups, although well-established, is considerably smaller than United Kingdom production in spite of the fact that per capita consumption of soup in France is about four times that in the United Kingdom (12); this is because most soup consumed in France is home-made.

Production of canned soup actually declined between 1960 and 1961, then showed a gradual upward trend until 1966 (increasing by 80 per cent between 1961 and 1966). However, since 1966 production has increased dramatically (by 240 per cent between 1966 and 1969) although without affecting the upward trend in sales of dried soups.

The figures for usage of dehydrated vegetables include use in the production of bouillons and canned soups besides use in dried soups, although the last-named is undoubtedly the most important outlet. It will be noted that usage has in fact fluctuated considerably and has not reflected the trend in soup production very accurately; however, usage has shown an upward trend since 1966. The quantities of dehydrated vegetables used by soup manufacturers amounted to eighty per cent of estimated total net demand in 1968 (see page 54) and to 78 per cent in 1969. Soup manufacturers accounted for 97 per cent of net demand for onions and 74 per cent of net demand for "other vegetables" (including potatoes) in 1968 compared with 94 per cent and 75 per cent respectively in 1969. Allowing for the fact that fluctuating inventories of raw materials affect the actual quantities of dehydrated vegetables used for soup manufacture, it is still evident that dried soup manufacturers dominate the market for dehydrated vegetables.

The three major dried soup brands in France are Maggi (Nestlé) — said to have 70 per cent of the market, followed by Knorr and Royco (Unilever). There are also a number of brands made by smaller foodstuffs manufacturers. Ready-meals are also sold under the Maggi label.

The major soup manufacturers forecast that sales of dried soups, and thus demand for dehydrated vegetables, will continue to increase at between 5 and 10 per cent per annum for the foreseeable future in view of the fact that the catering market for dried soups, though still limited, has increased rapidly in recent years.

b. Other food manufacturers

Use of dehydrated vegetables by food manufacturers other than soup manufacturers is still rather limited in France, apart from the use of garlic powder and dried herbs. However, manufacturers of baby foods, led by Sopad (associated with Nestlé), have begun to use dehydrated vegetables and the introduction of dried ready-meals on to the French market has also provided a new outlet. Use of dehydrated onions and other vegetables in the manufacture of food products does not yet seem to be widespread in France, possibly because of the difficulty of obtaining cheap, imported supplies, thus there would appear to be untapped potential demand in this market sector.

c. Catering and retail trade

This sector of the market is also extremely limited at present. One domestic producer has launched freeze-dried "Champignons de Paris" (button-mushrooms), onions and pea-puree on the catering and retail markets. However, the high unit cost of freeze-dried vegetables packed in cans seems likely to limit sales at retail level although their convenience may permit sales to catering establishments.

Institutional catering establishments (hospitals, schools, etc) do not yet appear to use dehydrated culinary vegetables, indeed sales of dried soups to such establishments have only begun to increase in the last few years. It seems unlikely that sales of culinary vegetables will become an important sector of the French market for dehydrated vegetables in the near future.

Terms of Trade and Margins

In view of the difficulties involved in importing dehydrated vegetables into France, there are no generally accepted terms of trade; it seems likely that most sales are made on a cif basis. Similarly there are no generally accepted margins at import level — those companies which import direct obviously avoid paying the importers' margin, while it is said that other imports are made speculatively, i.e. the importer sells for the best price he can make.

Prices

In the absence of published prices for dehydrated vegetables, the only data available on this subject are the average cif values of imports as calculated from the official Trade Returns. The average values are shown in Table 24.

Table 24
Average Annual cif values of Dehydrated Vegetables imported into France
£ per metric ton

Year	Onions	Potatoes	Others
1960	(a)	164	430
1961	208	...	1,100
1962	298	...	1,150
1963	344	...	1,075
1964	315	...	905
1965	302	237	939
1966	280	300	949
1967	277	...	820
1968	280	271	978
1969	274	...	829
1970	355	...	988

(a) Included with "others"

... Not available

Source: Derived from *Commerce Exterieur*

It will be noted that the average value of imports into France is generally somewhat higher than the values of United Kingdom imports. The value of imported onions was particularly high in the earlier years of the series, but from 1963 to 1969 their value (in sterling) showed a downward trend in spite of the 14.3 devaluation of sterling in late 1967. The very high average values of "other" vegetables is mainly due to the fact that imports under this category are largely of expensive types of vegetables e.g. *B.edulis* mushrooms and are weighted by small quantities of very highly priced imports from the Far East (probably dried herbs, possibly used in the perfumery industry). However in recent years larger quantities of relatively cheap vegetables (e.g. carrots) have been imported into France, which has resulted in a declining average value of imports. (The rise in average values between 1967 and 1968 can partly be accounted for by the devaluation of sterling in late 1967). In 1969 the range of values of imports from different countries was very wide, extending from £9,400 (\$ 22,600) per ton for imports from India, to £302 (\$ 725) per ton for imports from Israel (mostly carrots); imports from East European countries (largely *B.edulis* mushrooms) were valued between £1,052 (\$ 2,525) per ton (from Bulgaria) and £878 (\$2,107) per ton (from Yugoslavia), while imports from Morocco (assumed to be chiefly tomatoes) had an average value of £547 (\$ 1,313) per ton.

The only prices available for domestic produce are in respect of the freeze-dried vegetables produced by one company. In late 1970 freeze-dried champignons were priced at £5.46 (\$13.10) per kilo ex-works and onions at £2.43 (\$ 5.83) per kilo ex-works. These prices demonstrate the very high cost of freeze-dried vegetables.

Italy

Domestic Production

Like France, Italy is a relatively minor importer of dehydrated vegetables, but is of some importance as an exporter. Imports first exceeded exports in 1964 and Italy has remained a net importer ever since; indeed the gap between imports and exports widened progressively until 1968 before narrowing again in 1969 and 1970.

There are a number of producers of dehydrated vegetables in Italy, including at least one company with freeze-drying equipment.

Estimates of Italian production vary considerably, from 1,000 tons (1970 (13)) to 3,500 tons (1968 and 1969 (14 and 15)). The major types of vegetables processed are tomatoes, cauliflower, leeks and sweet peppers.

Imports

a. Total import demand

Italian imports of dehydrated vegetables showed a strong upward trend from 1960 to 1969, rising from 285 tons valued at £150,200 (\$420,600) to 1,632 tons valued at £1.18 million (\$2.84 million). The steady trend was broken by a peak of imports in 1964 (see Table 25). There was a decline in the tonnage of dehydrated vegetables imported in 1970 to 1,445 tons valued at £1.25 million (\$3.00 million).

Table 25
Imports of Dehydrated Vegetables into Italy 1960 to 1970. (Excluding capers and olives).

		Onions	Mushrooms and Truffles Not Powdered	Other Vegetables	Totals
1960	tons	(a)	185	100	285
	£'000	(a)	122.9	27.3	150.2
1961	tons	(a)	76	154	230
	£'000	(a)	131.1	38.6	169.7
1962	tons	112	205	71	388
	£'000	31.3	480.1	31.3	542.7
1963	tons	95	573	138	806
	£'000	28.0	521.0	61.5	610.5
1964	tons	114	994	157	1,265
	£'000	29.3	636.6	71.9	737.8
1965	tons	198	494	148	840
	£'000	47.0	385.0	65.9	497.9
1966	tons	139	563	244	946
	£'000	31.1	530.0	103.0	664.1
1967	tons	296	821	349	1,466
	£'000	74.9	673.9	158.2	907.0
1968	tons	148	(a)	1,394	1,542
	£'000	44.7	(a)	1,029.7	1,074.4
1969	tons	194	(a)	1,438	1,632
	£'000	57.0	(a)	1,125.0	1,182.0
1970	tons	264	(a)	1,181	1,445
	£'000	86.6	(a)	1,164.4	1,251.0

Source: *Commercio con l'Estero*
Istituto Centrale di Statistica
(a) included with "others"

b. Types of vegetables imported

Table 25 summarises Italian imports by type of vegetable for the period 1960 to 1970. Only two types of vegetables have been shown under separate categories — onions (since 1962) and mushrooms and truffles other than powdered in non-airtight containers (until 1967).

Mushrooms and truffles are the principal types of vegetables imported, although their relative importance declined from a peak of 79 per cent of total imports in 1964 to 56 per cent in 1967; however, it appears that imports of mushrooms and truffles increased again in 1968 and 1969. The mushrooms imported are almost entirely of the *B.edulis* type, but it is difficult to determine the relative importance of mushrooms and truffles in this category. Imports of dehydrated onions are of less importance and fluctuate from year to year, usually accounting for between 10 and 20 per cent of total imports.

c. Sources of supply

Table 26 summarises Italian imports of dehydrated vegetables by supplying country for the years 1965 to 1969. The major countries supplying the Italian market are those East European countries which export mushrooms and truffles — Yugoslavia, Roumania and Bulgaria; fellow members of the EEC — the Netherlands and Germany, and Egypt who is a major supplier of onions.

Table 26
Imports of Dehydrated Vegetables into Italy by country of origin

		1965	1966	1967	1968	1969 (a)	Share of Imports in 1969
TOTALS of which from:-	tons £'000	840 497.9	946 664.1	1,466 907.0	1,542 1,074.4	1,632 1,182.0	
Yugoslavia	tons £'000	280 226.6	379 384.4	600 478.0	853 654.0	764 594.6	47
Netherlands	tons £'000	73 33.9	185 68.9	271 105.5	164 75.1	...	...
Roumania	tons £'000	161 89.7	136 99.4	75 52.7	103 108.4	204 169.4	12
UAR Egypt	tons £'000	170 37.1	111 26.2	257 62.0	70 19.3	...	...
Bulgaria	tons £'000	34 32.2	38 30.3	90 65.3	149 96.9	139 96.3	8
Germany	tons £'000	11 18.8	23 18.0	61 61.3	61 41.8	118 102.7	7
United States	tons £'000	18 12.0	17 15.6	11 10.3	25 12.1	...	...
France	tons £'000	28 17.4	9 6.2	10 13.9	11 17.2	30 36.7	2
Lebanon	tons £'000	- -	2 0.4	10 2.7	34 9.1	...	...
Hungary	tons £'000	14 8.8	1 0.4	10 11.7	7 4.1	...	...
Turkey	tons £'000	16 2.9	5 1.1	5 1.0	2 0.5	...	...
Switzerland	tons £'000	1 0.7	7 4.0	5 2.8	4 2.0	...	...
United Kingdom	tons £'000	2 1.0	1 0.3	-	13 13.3	...	...
Other Countries	tons £'000	32 16.8	32 8.9	61 39.8	46 20.6	377 182.3	23

(a) Preliminary

- Nil or negligible

... Not separately shown

Source: *Commercio con l'Estero*

The first five countries listed together supplied about 85 per cent by weight of total imports during the period 1965 to 1969; Yugoslavia alone supplied 45 per cent. Thus the Italian market is dominated by a relatively small number of supplying countries. However it is interesting to note that Turkey has supplied small quantities of dehydrated vegetables to this market.

d. Imports of mushrooms and truffles

Imports of mushrooms and truffles in non-airtight containers (not powdered) were shown in a separate category in the Trade Returns until 1967, but estimates of imports in later years may be made from the "other vegetables" category. Imports of these vegetables have fluctuated considerably, rising from 185 tons valued at £122,900 (\$344,100) in 1960 to a peak of 994 tons valued at £636,600 (\$1,782,500) in 1964 before dropping to only 494 tons in the following year and increasing again to 821 tons valued at £673,900 (\$1,886,900) in 1967 and to about 1,100 tons in 1968 and 1969.

Throughout the period 1960 to 1969 Yugoslavia has been the dominant supplier of mushrooms and truffles to this market. In 1963 Yugoslavia was virtually the sole supplier to the Italian market and since then she has supplied between 56 and 87 per cent of total imports. Roumania has been a substantial supplier since 1964 accounting for between 9 and 33 per cent of imports. Bulgaria is the only other supplier of any importance, supplying an estimated 13 per cent of imports in 1968. Minor suppliers of mushrooms and truffles have included Poland, Hungary, Germany and France.

e. Imports of onions

Imports of dehydrated onions have been shown in a separate category in the Italian Trade Returns only since 1962. Imports in 1962 amounted to 112 tons valued at £31,300 (\$87,600) and although fluctuating from year to year, have since shown a general upward trend. Imports reached their peak in 1967 when 296 tons valued at £74,900 (\$209,700) were received. It seems likely that dehydrated onions are imported to make up a short-fall in domestic supplies.

Until 1967 imports of dehydrated onion powder were shown separately from imports of kibbled and sliced onions. Powdered onion was of minor importance, accounting for less than 20 per cent of imports of dehydrated onions from 1964 to 1967. The major supplier of both onion powder and kibbled onion was Egypt – until 1967 virtually the only supplier of any significance. However, since 1967 the Lebanon has become a substantial supplier to the Italian market, accounting for 23 per cent of imports in 1968 compared with 47 per cent supplied by Egypt. The Netherlands and the United States have also supplied this market, the latter country supplying 14 per cent of imports in 1968.

f. Imports of other vegetables

Before 1962 the "other vegetables" category included dehydrated onions and since 1968 mushrooms and truffles have been included with "other vegetables". From 1962 to 1967 imports of vegetables other than onions, mushrooms and truffles showed an upwards trend, rising from 71 tons valued at £31,300 (\$87,600) in 1962 to 349 tons valued at £158,200 (\$443,000) in 1967 – an increase of 392 per cent in tonnage terms. However since 1967 estimated imports of other vegetables appear to have levelled out (assuming that imports from Yugoslavia, Roumania and Bulgaria in 1968 and 1969 were entirely of mushrooms and truffles).

The major supplier of unspecified types of vegetables has been the Netherlands who supplied as much as 75 per cent of imports in 1966. Other countries which supplied significant quantities in certain years include the United States, Germany, Turkey and the Irish Republic.

Exports and Re-Exports

Until 1964 Italian exports exceeded German exports and Italy was third in importance among European exporters of dehydrated vegetables.

Italian exports over the period 1960 to 1970 are summarised in Table 27. Exports showed a rising trend from 615 tons in 1960 to about 1,100 tons in 1963 and 1964 before falling to about 600 tons in 1966 and 1967; since then exports have risen

again, exceeding 800 tons in 1969 and 1970.

Until 1962 only exports of mushrooms and truffles (possibly re-exports), not powdered, in non-airtight containers, were shown in a separate category in the Trade Returns. In 1962 separate categories were introduced for onions and tomatoes, not powdered, in air-tight containers but in 1968 the categories for mushrooms and truffles and tomatoes were abolished. Exports in all the individual categories fluctuated from year to year, although in most years exports of tomato flakes exceeded exports of onions or mushrooms and truffles. In 1967 tomato flakes in air-tight containers accounted for 11 per cent of exports, onions and mushrooms and truffles for 2 per cent each. Trade information suggests that tomato powder accounts for a large proportion of exports, followed by cauliflower, leeks and sweet peppers. In recent years the main markets for Italian exports have been Germany, the Netherlands, Switzerland, the United Kingdom and the United States.

However, it is interesting to note that according to the Netherlands' Trade Returns imports from Italy have exceeded 400 tons since 1967, in contrast to the 120 to 140 tons shown as being exported to the Netherlands in the Italian Trade Returns.

Table 27
Exports of Dehydrated Vegetables from Italy

	Onions	Mushrooms and		Tomatoes in Airtight Containers Not Powdered	Other Vegetables	TOTALS
		Onions	Truffles not Powdered			
1960	tons £'000	(a) (a)	19 31.6	(a) (a)	596 261.0	615 292.6
1961	tons £'000	(a) (a)	27 56.8	(a) (a)	542 285.7	569 342.5
1962	tons £'000	80 9.6	3 13.5	145 83.2	548 301.1	776 407.4
1963	tons £'000	162 10.1	5 16.2	116 72.4	820 459.3	1,103 558.0
1964	tons £'000	41 7.1	9 17.1	141 75.9	900 490.0	1,091 590.1
1965	tons £'000	85 9.7	8 15.1	31 19.8	501 327.3	625 371.9
1966	tons £'000	19 6.3	7 16.7	53 36.4	519 341.4	598 400.8
1967	tons £'000	15 7.7	10 20.2	69 34.9	509 325.7	603 388.5
1968	tons £'000	7 3.2	(a) (a)	(a) (a)	667 492.6	674 495.8
1969 (b)	tons £'000	12 13.2	(a) (a)	(a) (a)	816 610.8	828 624.0
1970 (b)	tons £'000	26 17.0	(a) (a)	(a) (a)	783 711.3	809 728.3

(a) Included with other vegetables

(b) Preliminary

Source: *Commercio con l'Estero*

Net Demand for Dehydrated Vegetables

In view of the conflicting estimates of domestic production of dehydrated vegetables, it is rather difficult to decide the level of net demand for dehydrated vegetables in Italy. If the higher figure for domestic production is taken, net demand over the period 1968 to 1970 ranged from 4,100 to 4,400 tons per annum, whereas the lower estimates suggest that net demand ranged from 1,640 to 1,870 tons per annum over the same period. Since outlets for dehydrated vegetables seem rather limited in Italy (e.g. the dried soup industry is small compared with that in most other European countries) and the major domestic producers

export a large proportion of their production (16), the lower estimate seems more likely to be the true figure for net demand.

Outlets

As mentioned above the dried soup industry is relatively small in Italy. It is thought that the considerable quantities of mushrooms imported are used in a wide range of manufactured foods and probably by bakers and the catering industry also.

Prices

The only price data available for the Italian market are average import values calculated from the Trade Returns as shown in Table 28 below.

Table 28
Average Annual cif Values of Dehydrated Vegetables imported into Italy.
£ per ton

Year	Onions	Mushrooms and Truffles	Others
1960	(a)	664	273
1961	(a)	1,725	251
1962	279	2,342	441
1963	295	909	446
1964	257	640	458
1965	237	779	445
1966	224	941	422
1967	253	821	453
1968	302	(a)	739
1969	294	(a)	782
1970	328	(a)	986

(a) included with "others"

Source: derived from *Commercio con l'Estero*

The average import value of onions showed a downward trend from 1963 to 1966 before rising to a record level in 1970. It should be noted that the rise in values between 1967 and 1968 is partly accounted for by the conversion of lira to sterling, the latter currency having been devalued by 14.3 per cent at the end of 1967.

On the whole the average import value of onions has been somewhat above those of imports into the United Kingdom and the Netherlands and below those of imports into France and Belgium.

The average values of imports of mushrooms and truffles fluctuated considerably, the lowest value — £640 per ton (\$1790) occurring in 1963 when the tonnage imported exceeded the previous year's imports by 180 per cent. Between 1962 and 1967 the average value of other vegetables remained remarkably steady, ranging from £422 to £458 per ton (\$1,180 to \$1,280 per ton); the inclusion in this category of onions before 1962 and mushrooms after 1967 obscures any overall trend in price.

Prospects

The countries of Western Europe together account for a major proportion of world imports and in the period 1965 to 1969 imports into Western Europe increased more rapidly than total world imports.

In the five countries examined in Part I of this report import demand rose by an estimated 68 per cent between 1965 and 1969. In the Netherlands and France manufacturers of dried soups are the dominant outlet for dehydrated vegetables and demand from other manufacturers and from catering concerns is still very limited. In the United Kingdom on the other hand, manufacturers of dried soups now account for less than 40 per cent of the market for dehydrated vegetables, usage by other manufacturers is increasing and the catering and retail trade in dried culinary vegetables accounts for a significant proportion of demand. In Italy the market for dried soups is relatively small and a large proportion of dehydrated vegetable imports is of mushrooms and truffles which are probably used by a wide range of food manufacturers, bakers and caterers. Belgium is rather a special case, being a very minor importer of dehydrated vegetables and having only one relatively minor, dried soup manufacturer in the country — imported dehydrated vegetables are used by a number of food manufacturers and also by caterers to a minor extent.

Although demand for dried soup is not expected to increase as rapidly in the future as it did between 1965 and 1969, soup manufacturers forecast a continuing rise in dried soup production and in demand for dehydrated vegetables of about 5 per cent per annum for the next few years (except in Belgium). On the other hand demand from other manufacturers and from catering concerns is expected to increase more rapidly in future in the Netherlands, France and Belgium, admittedly from a very low base. In the United Kingdom where use of dehydrated vegetables is already widespread, no acceleration in the rate of increase in demand is expected, indeed retail demand for dehydrated vegetables now seems to be static, if not declining.

All five countries surveyed have domestic dehydration industries. In the United Kingdom production is probably static and the major types of vegetables dehydrated are potatoes and peas which are not items likely to be produced in developing countries. In the Netherlands, France and Italy the domestic dehydration industries supply a wide range of vegetables and account for an important share of the market; production in France, the Netherlands and Italy appears to have risen in recent years. However, imports appear to be enjoying a larger share of the market in the Netherlands and France and indications are that this would be even more pronounced for France if imports were not restricted by quota. Italian imports are largely of mushrooms, which do not compete directly with domestic production and it is impossible to determine whether the other types of vegetables imported are increasing their share of the market. Imports are an important source of supply for the Belgian dehydrated vegetable market. In view of rising raw material and labour costs in Europe, domestically-produced dehydrated vegetables will almost certainly become less price-competitive compared with imported vegetables, and so long as producers in Southern Europe (Spain and Portugal) and other parts of the world can meet buyers' quality requirements,

especially as regards bacteriological limits, imports are likely to take an increasing share of European markets for dehydrated vegetables.

If present import trends are projected to 1975, import demand in that year may be estimated as follows:-

Table 29

Estimated Imports into five European Countries for 1975, compared with 1970 Imports of Dehydrated Vegetables.

	Dehydrated Onions			Other Vegetables			Totals		
	1970	1975	% increase	1970	1975	% increase	1970	1975	% increase
United Kingdom	7,895	8,910	13	7,679	8,640	12	15,574	17,550	13
Netherlands	2,335*	2,880*	23	3,607	4,490	25	5,942	7,370	24
Belgium	134*	140*	2	284	370	29	418	510	20
France	385	540	40	1,432	1,790	25	1,817	2,330	28
Italy	264	350	31	1,181	1,990	68	1,445	2,340	61
Totals	11,013	12,820	16	14,183	17,280	22	25,196	30,100	19

*Net imports.

These estimates are based on a straight line projection of the import data for the years 1960 to 1970 inclusive, since changes in underlying demand patterns (e.g. increasing catering demand) are difficult to take account of in more complex estimating procedures.* The estimates for the United Kingdom and Belgium are subject to certain provisos; the basic data for United Kingdom imports before 1968 had to be estimated to some extent, thus affecting the reliability of forward extrapolation; Belgian imports of dehydrated onions have shown wide fluctuations from year to year and re-exports frequently constitute a large proportion of gross imports, thus the estimation of a trend in net imports is rather difficult. French imports will to some extent depend on the willingness of the French authorities to grant import licences.

Nevertheless if the estimates given in Table 29 are taken to be a reasonable forecast of future trends, it may be assumed that imports into the United Kingdom will increase relatively slowly and imports into Italy will increase rapidly (in percentage terms). However, the greatest absolute increases in demand will occur in the United Kingdom and the Netherlands. Belgium will remain a very limited market. Demand for dehydrated onions will increase less rapidly than demand for other vegetables overall, but in the United Kingdom and France demand for onions will increase more rapidly than total demand.

In spite of year to year (and sometimes much more rapid) fluctuations in prices, the general price trend for most types of dehydrated vegetables imported into Europe, has been upward in recent years. Although price-levels, as depicted by the average c.i.f. values calculated from the Trade Returns, appear to vary from one country to another within Europe, these figures are probably affected by the relative importance of different suppliers and the types of cut preferred in each country. The market in dehydrated vegetables is in fact very international, at least within Europe, and in the opinion of members of the trade there is no longer any significant difference in import price-levels between individual European countries.

Price trends may of course affect demand, especially that of firms where dehydrated vegetables are used as substitutes for fresh or other types of processed vegetables. In the United Kingdom some firms which are able to use either fresh or dehydrated vegetables will only buy the latter when they are cheaper than prepared fresh vegetables. Thus a rise in price above the "break-even" point can reduce demand substantially. Where fresh vegetables cannot be substituted firms may substitute cheaper types of dehydrated vegetables for those that have risen in price. Soup manufacturers in the United Kingdom are said to be extremely price-conscious and more prepared than their counterparts in continental Europe to alter the recipes of their soups.

* It is possible that the resultant estimates of import demand are somewhat conservative.

It is not clear whether, if the United Kingdom joins the EEC, the subsequent raising of United Kingdom import duties would increase I.d.p. prices in the UK by the full amount of the tariff increase. However, the tariff increases will be phased, increasing by one-fifth of the difference between the UK and EEC tariffs per annum. It is possible that the increase in tariffs will make dehydrated vegetables imported from outside the EEC and its associates less price-competitive with fresh vegetables and thus reduce demand, at least in the short term.

In a situation of increasing demand and rising prices for dehydrated vegetables the prospects for a new producer entering the market appear quite promising. However, it must be emphasised that this is a very competitive market and the number of countries with dehydration industries has increased in the last two or three years to include a number of developing countries e.g. Peru, India, Sudan. Competition is based on quality as well as price and new producers must offer dehydrated vegetables of high quality in order to enter the market. Nevertheless importers in European countries are interested in obtaining new sources of supply and are generally willing to assist a new producer to become established in the market. New producers are advised to appoint an agent to sell their products in the first instance.

Countries having an equable climate which permits a long harvesting season for a single type of vegetable probably have an advantage over countries where the harvesting period for any vegetable is short — a long harvesting season permits the processor to specialise in the production of relatively few vegetables (which has proved more profitable than production of a wide range of vegetables); also the processed product need not be stored for a long period in order to permit shipment over the year.

Many new entrants to the dehydrated vegetable market begin by producing dehydrated onions, since onions are in greater demand than any other type of dehydrated vegetable and in recent years demand has been increasing more rapidly than supply. The current market position (1971) is one of over-supply and depressed prices; this situation is not likely to persist although a return to the excessively strong demand position and high prices of 1969 and 1970 is not expected. Demand is more likely to increase when prices of dehydrated onions compare favourably with the cost of prepared raw onions; the break-even point stands at about £0.45 per kilo (\$1.06 per kilo) in the United Kingdom. For successful production of dehydrated onions varieties having a high dry-matter content must be grown and these should be white varieties of onions since European markets only require white or slightly yellow dehydrated onions. Other types of dehydrated vegetables for which demand is substantial include carrots and leeks, although it is very difficult to remove all the soil and dirt from dehydrated leek flakes. Any country able to supply *B.edulis* mushrooms (which grow wild in a number of East European countries) would find a good market, since supplies from the traditional supplying countries have declined in recent years. Another highly-priced vegetable for which the market prospects seem promising is asparagus, although demand is rather limited.

There are a number of vegetables for which demand is considerable but whose production poses certain problems. Although there is a large and rapidly expanding demand for dehydrated potatoes in many European countries, this is a low-priced commodity and the raw material can probably be grown more cheaply in Northern Europe than in countries with warm climates. Tomatoes, another type of dehydrated vegetable imported in large quantities, also pose problems in that while tomato flakes can be produced in conventional air-drying plant, tomato powder (for which demand is greater) is manufactured by spray-drying tomato puree — an entirely different process. One vegetable whose market has effectively been "cornered" by European producers is the pea, dehydrated on a large scale in the United Kingdom and the Irish Republic. There are few countries in the world (even in Western Europe) which can grow such high-quality garden peas as the British Isles and it is doubtful whether overseas producers could capture a share of the market.

At present there is very little demand for freeze-dried vegetables in the European markets studied in this report because of their high cost in comparison with air-dried vegetables. The improvement in the quality of air-dried vegetables over the last decade has probably in fact led to a reduction in demand for freeze-dried vegetables. Only the Dutch dried soup industry uses significant quantities of freeze-dried vegetables at the present time and the only freeze-dried vegetables used in any quantity as culinary vegetables are peas processed in the Irish Republic. There is a limited demand for freeze-dried vegetables such as champignon mushrooms and asparagus tips for garnishing purposes but this probably amounts to less than 25 tons per annum in the five countries studied. Freeze-drying is used principally for the dehydration of meat, poultry and shell-fish at present. Until production costs are reduced, there is unlikely to be a significant demand for freeze-dried vegetables.

References

1. "Breakthrough in Dehydration", **Food Industries of South Africa**, 1971, 18, 12, pp 25 & 26
2. *Ibid.* pp 26 & 27
3. "Horticulture in the Mediterranean Area" Commodity Bulletin Series No.42 FAO Rome 1968
4. Commonwealth Secretariat, **Fruit Intelligence**, 1969, 19, 8, p 569
5. "Breakthrough in Dehydration", **Food Industries of South Africa**, 1971, 18, 12, p 27
6. "Ready Meals", Economist Intelligence Unit, **Retail Business**, 1969, 142, p 35
7. *Ibid.* p 35
8. Commonwealth Secretariat, **Fruit Intelligence**, 1971, 21, 5, p 316
9. "Canned and Packet Soup in the Netherlands", EIU, **Marketing in Europe**, 1971, 98, p 41
10. *Ibid* p 39
11. *Ibid* p 42
12. *Ibid* p 39
13. Italian Institute for Foreign Trade, Private Communication
14. "Echo des Halles", 1969, 18, September 11, p 1
15. **Economie Générale**, 1971, May 20, Mpp 4
16. Italim SPA, Private Communication

Appendix

FIRMS TRADING IN DEHYDRATED VEGETABLES

Note:

The following list gives the names of some of the firms which are known to the Tropical Products Institute to be trading in this commodity, but the list should not be regarded as exhaustive. Inclusion in the list does not imply that TPI has any knowledge of the financial standing of the firms.

UNITED KINGDOM

Importers

Briess & Co. Ltd.,
Plantation House,
Mincing Lane,
London EC3

C. J. P. (Produce Ltd.)
6 Borough High Street,
London SE1

Demby, Hamilton & Co. Ltd.,
Berisford House,
50 Mark Lane,
London EC3

Lukus (London) Ltd.,
Peninsular House,
28 Monument Street,
London EC3

R. H. Rolfe & Co. Ltd.,
Peninsular House,
28 Monument Street,
London EC3

S & S Services Ltd.,
Abford House,
Wilton Road,
London SW1

R. Sarant & Co. Ltd.,
147 London Road,
Kingston-on-Thames,
Surrey

Sec Foods Ltd.,
St. Ann's Lane,
Boston,
Lincolnshire

John F. Seyfried & Sons Ltd.,
1 Great Cumberland Place,
London W1

Manufacturers

Batchelor's Foods Ltd.,
Wadsley Bridge,
Sheffield S6 2NG

Brown and Polson Ltd.,
PO Box 1,
Paisley,
Renfrewshire

H. J. Heinz Co. Ltd.,
Hayes Park,
Hayes,
Middlesex

MacDougall's Catering Foods Ltd.,
Basingstoke Road,
Reading,
Berkshire

The Nestlé Co. Ltd.,
St. Georges House,
Croydon,
Surrey

Swel Foods Ltd.,
Dawnedge,
Apsley Guise,
Bletchley,
Buckinghamshire

NETHERLANDS

Importers

Dika Fabrieken NV,
Postbus 5
Schoonhoven

Van Eeghen & Co.,
Herengracht 464
PO Box 3699
Amsterdam

Preservenbedrijf N.V.
PO Box 207
Breda

Wilco Conserven N.V.
Asseen

E. H. Worlee & Co. (Amsterdam) N.V.
Minervalaan
PO Box 7165
Amsterdam

Manufacturers

Honig Merkartikelen N.V.
Havenweg 24
Nijmegen

Nestlé N.V.
Haalemmerweg
Amsterdam

Royco Voedingsmiddelenfabrieken N.V.
Veilingstraat 10
Utrecht

BELGIUM

Importer

S. A. Donck,
B-2620 Hemiksem
Antwerp

Manufacturer

Brooke Bond Liebig Benelux SA
St Katelijnevest 54
B-2000
Antwerp

FRANCE

Trade Association

Syndicat National des Fabricants de Bouillons et Potages
12 Rue du 4 Septembre
Paris 2^o.

Manufacturers

Astra-Calvé (Royco)
Tour Europe
La Defense
92 Courbevoie

Bloch-Potalux
B.P. 2
54 – Tomblaine
Nancy

Ste des Produits du Maïs (Knorr)
379 Avenue de la Libération
92 – Clamart

SOPAD (Maggi)
7 Rue Euryale Dehaynin
Paris 19^o.





